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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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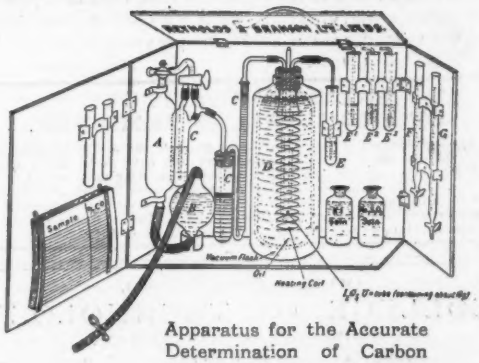

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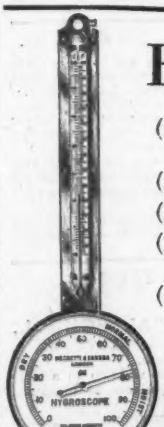

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P. J. HARTOG, Academic Registrar.

RAMSAY MEMORIAL FELLOWSHIP FOR CHEMICAL RESEARCH.

The Trustees will consider at the end of June, 1920, applications for FELLOWSHIPS not exceeding three in number. The value of each Fellowship will be £250 per annum, to which may be added a grant for expenses not exceeding £50 per annum. The Fellowship will normally be tenable for two years, and may be extended for a third year.

Full particulars can be obtained from the undersigned, to whom applications must be forwarded not later than June 15, 1920.

WALTER W. SETON,
Organising Secretary,
Ramsay Memorial Fund.

University College, London
(Gower Street, W.C. 1).

CHEMICAL SOCIETY RESEARCH FUND.

A Meeting of the Research Fund Committee will be held in June next. Applications for Grants, to be made on forms which can be obtained from the Assistant Secretary, Chemical Society, Burlington House, W.1, must be received on or before Tuesday, June 1, 1920.

All persons who received grants in June, 1919, or in June of any previous year, whose accounts have not been declared closed by the Council, are reminded that reports must be returned by Tuesday, June 1, 1920.

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY.

Applications for Fellowships (£250 p.a.) of the above Institute are invited from those who in October next will have completed 3 years' training in chemistry and desire ultimately to enter upon an industrial career. Fellows will be required to pursue some branch of chemical investigation at an approved college or university. Full particulars of training and war service should be sent before July 1 to the DIRECTOR of the INSTITUTE, Salters' Hall, St. Swithin's Lane, E.C. 4.

MANCHESTER MUNICIPAL

COLLEGE OF TECHNOLOGY

(UNIVERSITY OF MANCHESTER).

Students desiring to enter upon one of the courses leading to the degree of Bachelor of Technical Science in the University of Manchester or to the University Certificate in Technology for the first time at the beginning of the Session 1920-1921 should apply not later than 20th May to the Registrar, College of Technology, from whom forms of application may be obtained. A first selection of applicants will then be made.

INDIAN AGRICULTURAL SERVICE.

Applications are invited for about 48 appointments which will be made in July next. Detailed regulations and forms of application may be obtained from the REVENUE SECRETARY, India Office, Whitehall, London, S.W.1. Applications for appointment must be received not later than June 1, 1920. About one half of the vacancies are administrative appointments in the Agricultural Departments; the remainder are scientific research or teaching appointments, including botanists, chemists, mycologists, etc.

Candidates should be between 23 and 30 years of age, but this rule may be relaxed, especially in the case of men who have served in His Majesty's Forces during the war. University degrees or Agricultural diplomas are necessary.

The ordinary scale of pay is Rs. 500 a month, rising by annual increments of Rs.50 a month to Rs. 1500 a month, with selection posts on higher rates of pay.

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Preference will be given, in the case of male candidates, to those who have served, or attempted to serve, with H.M. Forces.

Apply (enclosing stamped addressed foolscap envelope) to the EDUCATION OFFICER (T.3.), London County Council, Education Offices, Victoria Embankment, W.C.2. Form T.3/3 will then be sent and must be returned by 11 a.m. on May 26, 1920. Canvassing disqualifies.

JAMES BIRD,
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THE PROFESSORSHIPS OF ANATOMY AND PHYSIOLOGY.

The Governing Body invites applications for these Professorships. Applications must reach me on or before May 31, 1920. Additional information in reference to these Professorships can be obtained from me.

J. HYNES, Secretary.

April 27, 1920.

THURSDAY, MAY 13, 1920.

The Federation of Science.

WE referred last week to the harassed condition in which many scientific societies find themselves in consequence of the greatly increased cost of publication of papers communicated to them, and other additional expenses involved in the rise in prices. While the incomes remain much the same as they were before the war, the essential expenditure has become so much greater in proportion to them that the outlook is depressing to contemplate. Any increases in subscriptions which would prevent the younger scientific workers from joining learned societies, or cause a number of present members to resign would be detrimental not only to British science, but also to the extension of natural knowledge and to the welfare of mankind. The fields are ripe, and more labourers are now being trained to work in them than ever before, but if advantage is to be taken of the harvest, machinery for carrying it must be provided, and granaries built in which it can be stored. As things are at present, most of the scientific grain is cut by voluntary workers, and they are perplexed because they cannot see how they are to pay for the construction of a building in which to store it for the benefit of the community.

We are painfully reminded of this association of high motive with restricted effectiveness by the third annual report, which reached us a few days ago and is summarised on another page, of the Conjoint Board of Scientific Societies. The Board was constituted in 1916 for the purpose of "promoting the co-operation of those interested in pure or applied science; supplying a means by which the scientific opinion of the country may, on matters relating to science, industry, and education, find effective expression; taking such action as may be necessary to promote the application of science to our industries and to the service of the nation; and discussing scientific questions in which international co-operation seems desirable." In the main, these objects are much the same as those of the British Science Guild, founded by Sir Norman Lockyer in 1905, but the constitutions of the two bodies are different. Whereas the British Science Guild aims at securing the active interest and support of all members of the public who desire to promote the application of science and scientific method to national and provincial affairs of every kind, membership of the Conjoint Board is limited to representatives nominated by scientific and technical societies.

The total number of constituent societies now represented on the Board is fifty-seven, and it includes practically all the leading British societies concerned with the advancement of science and technology. The Royal Society sends four representatives, and the other societies one or two, the total number being eighty-seven, and including leaders in all departments of science and technology. We have, therefore, in the Board a federation or union which can faithfully represent joint opinion upon any scientific or technical matter of national importance submitted to it. The organisation is thus admirable for its purposes, but, as in all like British institutions, it has not the means to carry out its aims and objects. The funds of the Board are derived from contributions from the constituent societies, and these amounted last year to about 600*l*. Three societies have intimated that they are unable to make a contribution this year, owing apparently to the necessity for limiting in every possible direction the claims upon their incomes, so that this splendid organisation not only finds its activities hampered through a miserably inadequate income, but must also contemplate the future with serious misgiving. For though British science may organise itself, it has not the means to provide the motive power for the machinery it has created.

How different the conditions are in the United States may be judged from the article upon the National Research Council printed elsewhere in this issue. Like the Conjoint Board—or Federation, as it should have been called, to prevent confusion with the medical Conjoint Board—the National Research Council was started by men of science themselves, and represents their efforts to mobilise the whole strength of American science for the promotion of national well-being and the advance of science itself. While recognised by the United States Government, the Council was not organised by it, and is not supported by it. The Council's funds are derived from private sources, and the Carnegie Corporation alone has contributed no less than one million pounds, which is the amount given by our Government in 1916 in establishing the Department of Scientific and Industrial Research "for the conduct of research for the benefit of the national industries on a co-operative basis." The Council has permanent headquarters at Washington, with an executive

staff of men of science giving their whole time to the work of their respective positions. While it favours well-planned co-operation and organised effort in connection with the solution of particular problems, it is opposed to all attempts at central control of research, and to any action which may hamper the individual investigator or hinder personal initiative.

The National Research Council has thus like functions to those of our Department of Scientific and Industrial Research, but its constitution is different, and approaches more closely that of the Conjoint Board of Scientific Societies. It is not financed by the U.S. Government, and is, therefore, not a Government bureau, but a federation of the principal research agencies in the United States concerned with the fields of science and technology. Men of science in America are fortunate in securing the generous support of private benefactors for the work of their National Council. They are in consequence perfectly free to determine their own policy and to shape their own destiny, untrammelled by any of the conditions laid down by administrators unfamiliar with their spirit or their service.

Much of the misunderstanding which exists among many of our men of science concerning the Department of Scientific and Industrial Research would be avoided if the constitution of the Department were on the democratic lines of the National Research Council. We do not wish to depreciate the work of the Department in the slightest—indeed, its very important activities in some directions have often been commented upon in our columns—but we think the work could be extended and made more effective if the suspicion of bureaucratic control could be removed completely by placing responsibility for it more definitely upon the body of scientific opinion. The men who administer the grants in aid made by the Royal Society, British Association, and other scientific societies represent the fellows or members of these societies, and are not appointed by other persons or bodies. This is the case also in the National Research Council, and we suggest that our Department of Scientific and Industrial Research might relieve itself of the criticism to which it is sometimes subjected by making its Advisory Council similarly representative of scientific opinion.

Even if this change of constitution cannot be readily made, we have in the Conjoint Board a means at hand of removing existing objections. The Department might make the Board a part of its administrative machinery and pay it an annual retaining fee for service in a consultative capacity, without giving it any executive functions. The Board would thus serve as *liaison* officer between the Department and scientific societies, and science workers as a body would share responsibility with the Department in the selection of subjects for investigation which should be supported, and of societies to which these might suitably be entrusted. If our rich citizens and corporations were as generously disposed towards science and education as those of the United States, the Conjoint Board would be able to carry on its work as effectively as the National Research Council, without connection with a Department of Government. There is, however, little hope that such aid will be forthcoming, and in its absence the Department could with advantage use an organisation very similar in constitution to the National Research Council, but, unfortunately, without the funds to do like service for science.

Though the Conjoint Board was associated with the establishment of the Department of Scientific and Industrial Research, it has hitherto received little aid from the Department, and has had to carry on its very useful work mainly through its own slender resources. Among the important subjects dealt with by committees of the Board are the application of science to agriculture, national instruction in technical optics, the possible relation between magnetic anomalies and the presence of iron ores, water-power of the British Empire, timber for aeroplane construction, glue and other adhesives, Patent Laws, and the need for a joint building for scientific and technical societies. In New York there is a splendid building of this kind, and the National Research Council proposes to expend 200,000*l.* on its headquarters. Here there is nothing to compare with such accommodation for joint housing and meetings of scientific and technical workers. Science has organised itself in the Board as well as shown directions in which organised effort may profitably move. What is wanted now is what scientific workers are unable themselves to provide, namely, sufficient funds to enable the Board to continue and extend its operations on a firm financial basis. We hope the Department of Scientific and Industrial Research will be able to afford some aid of this kind, while we pray that private benefactors will arise who will place the Board in the same independent and strong scientific position as is enjoyed by the National Research Council of the United States.

Lord Kitchener as a Scientific Worker.

Life of Lord Kitchener. By Sir George Arthur. In three volumes. Vol. i. Pp. xxvi+326. Vol. ii. Pp. xi+346. Vol. iii. Pp. xi+413. (London: Macmillan and Co., Ltd., 1920.) Price 2*l.* 12*s.* 6*d.* net.

SIR GEORGE ARTHUR'S account of the work of the eminent soldier and administrator who is the subject of his three volumes is impressive not only on account of the series of successes which Lord Kitchener obtained in different and dissimilar fields, but also because of the methods by which so much was attained, for the biography is presented with such vividness that the careful reader can discern the man apart from his work. It is true that many of the episodes in the career of Lord Kitchener are mentioned with scarcely a comment, where expansion would have been desirable. Nevertheless, there is sufficient for interest and instruction in the mere relation of the stirring events in which he played so prominent a part. To have dealt with them in detail would perhaps have unduly expanded the volumes.

Kitchener possessed a variety of qualities and tastes obvious only to his intimates. Those not in intimate official relation with him in his work cannot readily form a conception of his methods. How much of his inflexibility he owed to his never having been cast in the public-school mould it is impossible to say, but to his early scientific training and his scientific tastes he no doubt owed the precision and accuracy which he required from those about him and to which he subjected himself. He was a quick thinker, readily grasping the conceptions of others, rapid in his decisions, rejecting or accepting proposals with astonishing celerity. The initiative always lay with him. It was he who gave scientific form to all his own projects. The spirit was his. It is the personality of the man which interests us as we pass from work to work.

His methods were not those of the orthodox administrator, and we cannot conceive Kitchener sheltering himself behind committees, though he frequently summoned conferences. Lord Salisbury, in his preface to the book, describes him as a man of sentiment, and pre-eminently as a man of imagination. Nothing can be more true; but it would be a mistake to suppose that, "bold and independent" as was his mind, he undervalued the opinions of experts who ventured to question his conclusions. If he never argued, he was ready to listen, and the latitude which he gave to a subordinate in devising means to an end was the measure of that confidence he reposed in his staff which was his marked characteristic. His conclusions were ever his own, and were irrevocable. Although to him the end was everything, he was less impatient of detail than is generally supposed. For precedent, of course, he cared nothing.

The truth appears to be that Kitchener's early scientific training profoundly influenced him in his subsequent career. That earnestness which he displayed in the solution of engineering undertakings was as evident in his readiness to adapt new knowledge in any branch of science to the solution of his administrative problems, and experts could readily discern the scientific method by which he reached his conclusions, for he reasoned from facts. As Sir George Arthur alludes only very briefly to the influence which Kitchener, as Commander-in-Chief in India, exerted on the reduction of disease and invaliding incidence in the Army of India, this influence is likely to be overlooked. In the history of this branch of Army administration the work of the Commander-in-Chief must always occupy a prominent place. Here he left a permanent monument to himself. It would have been strange had it been otherwise, for by his previous training and experience problems of public health were certain to appeal to him by reason of their bearing upon Army efficiency, and so we read:—

"Recent discoveries in bacteriology facilitated a systematic investigation which Kitchener, after the conference of 1905, instituted into the causation and origin of these maladies: a campaign against the house-fly, with its nidus in the night-soil accumulated near cantonments, and the mosquito —the recognised agents of the two diseases— resulted in a most significant drop of nearly one-half in the death and sickness rates. Stringent preventive regulations were issued as to sanitation, inoculation for malaris [*sic*], the purification of water, and the preservation of all food and drink from contamination; and it was peremptorily ordered that all persons—British or Native —before being employed in the preparation of any sort of eatables intended for the troops, should undergo a medical examination. Depots were also established in the hills for enteric convalescents, often carriers, who had hitherto not been sufficiently recognised as a source of danger to their comrades; and technical training in hygiene was provided for selected N.C.O.'s and men, each of these sanitary sections being supervised by a medical officer."

Similarly we see in other incidents the influence of Kitchener's early training and his scientific sympathies in many of his epoch-making measures. He was a lover of learning, and had that delight in it which we are told he endeavoured to inculcate in the students of the Staff College

at Quetta. His foundation of this college and his establishment of the institution at Khartum are evidence sufficient of his interest in education. Indeed, in his knowledge of science and in his appreciation of its utility Kitchener may be said to stand alone amongst great military administrators.

We get some clue to the Kitchener method if we bear these facts in mind, and we are enabled to see how, forsaking the practice of a scientific profession for the more ambitious sphere of civil administration and diplomacy, varying these with intervals of command of armies in peace and war, ending as an organiser of victory, he accomplished his ends with such extraordinary success.

No account of the life and work of this man will ever be complete which neglects a consideration of the influence exerted upon him by his early education. Kitchener understood the language of men of science. Consciously or unconsciously he adopted their methods. He was never out of date. We get a clue to his dislike of the bureaucrat, to his hatred of red tape, and to his contempt for precedent and of War Office methods, if we bear these in mind. We are not surprised when we hear that he "would rather sweep a crossing" than go to the War Office, for freedom to work on new lines—"always a learner," as his biographer tells us—was the very essence of the Kitchener method. When Lord Curzon and Lord Haldane characterised his organisation of the Army in India as "scientific" they were nearer the mark than perhaps even they recognised; for in the widest acceptation of the term Kitchener was a man of science, and Sir George Arthur's record of his remarkable career will find many appreciative readers in the scientific world.

The Nation's Food.

Food Supplies in Peace and War. By Sir R. Henry Rew. Pp. vii + 183. (London: Longmans, Green, and Co., 1920.) Price 6*s.* 6*d.* net.

SIR HENRY REW has the happy and unusual faculty of making statistics interesting; indeed, the only time when he is less interesting than usual is when he is quoting fewer figures. In this little book he has brought together the vital statistics of British food supplies and set them out: they tell their own tale so plainly that even the ordinary non-statistical person can understand.

The book was badly needed, for it is highly important that the average man should realise the facts. Unfortunately, agricultural policy is a matter for politics and emotions, and political considerations have sometimes been more in evidence than facts or business principles. Recently a bishop wrote to the *Times* making the astonishing statement that he thought the bread subsidy was paid to farmers to encourage corn production. If such amazing lack of knowledge can occur in high places, what must be the state of the ordinary voter's mind? Sir Henry Rew's book will supply the facts for those who will take the trouble to read it.

In the first chapter he deals with the problem as it was before the war, when we had a considerable balance of money due from abroad which we could take either in food or in other commodities. The general result is shown in the following table:—

—	Weight in metric tons used in the United Kingdom per annum.[1]		
	Home-grown.	Imported.	Total.
Cereals	1,010,000	3,855,000	4,865,000
Meat	1,615,000	1,070,000	2,685,000
Poultry, eggs, game, and rabbits	170,000	161,000	331,000
Fish	715,500	132,900	848,400
Dairy produce (including lard and margarine) ...	4,704,000	527,800	5,231,800
Fruit	341,000	930,000	1,271,000
Potatoes and other vegetables	4,788,000	694,000	5,482,000
Sugar (including cocoa and chocolate)	—	1,657,000	1,657,000

[1] A certain amount of cottage and farm produce is not included in the above table.

About one-fifth of the cereals, more than half the meat, and nine-tenths of the dairy produce and of the potatoes were home-grown. The total amount of foodstuffs, home-grown and imported, was considerable, and the nation was amply supplied with food. In 1913 the main sources of supply outside the United Kingdom were, in order of value of shipments, the United States, Argentina, Denmark, Canada, India, Australia, Russia, the Netherlands, Germany, New Zealand, Austria-Hungary, France, Spain, and Ceylon.

The second section of the book deals with war-time conditions. The outbreak of the war came, no doubt deliberately, at the time when the harvest of Central Europe was practically all gathered in, and when, therefore, there were ample stocks of food for a year. On our side the wheat crop in the United States was good, and although in Canada it was short, the total North American supply was well above the average. The year 1915 opened badly, as the Russian supplies were cut off in February. The situation was saved,

however, by the heavy crops in India and Argentina. Australia considerably increased her wheat area, as did also the United States and Canada; indeed, during the first year of the war the wheat area of the world was extended by more than 18,000,000 acres. In the later years of the war the difficulty was one of transport rather than of total supply; a great effort was therefore made after the close of 1916 to increase food production in the United Kingdom. The methods and results have been discussed from time to time in these columns: the general result was a steady increase in production right up to 1918, the figures for the United Kingdom being in thousands:—

		1914	1915	1916	1917	1918
Wheat ...	quarters	7,804	9,239	7,472	8,040	11,643
Barley ...	,,	8,066	5,862	6,613	7,185	7,760
Oats ...	,,	20,664	22,308	21,334	26,021	31,196
Beans ...	,,	1,120	924	893	474	931
Peas ..	,,	374	300	261	278	441
Potatoes...	tons	7,476	7,540	5,469	8,604	9,223

This high production was obtained at a time when manures were scarce and implements difficult to repair, and when most of the skilled men were gone, their places being taken by old people, women, and children. But these substitutes worked with a will, and amply made up in enthusiasm what they lacked in skill. Even the high production of 1918 was not the maximum possible, and had the conditions persisted, even higher results could have been obtained.

The last section of the book deals with post-war conditions. Serious fears had been entertained as to the food supplies of the world; fortunately, these have not been realised, and although food is undoubtedly scarce and will remain so there is no reason to fear famine, and in the main the people of Europe, though still suffering privation, are better fed than they were in 1918. It is difficult to say what the position is likely to be in the near future, but the redeeming feature is the rapidity with which agriculture has been restarted in the devastated areas of France and Belgium. Of the 4,000,000 acres damaged by the war, nearly a quarter were handed back to the cultivators before a year had elapsed. On the other hand, agriculturists in our own country are not producing so much as they did. The withdrawal of the women from the land and their replacement by men coincided with a considerable fall in production, which is distinctly unfortunate. A further fall is anticipated as a result of the shortened hours of labour.

Other countries, however, are in a worse predicament. Russia, formerly one of the chief wheat-producing countries of the world, is unlikely to have any exportable surplus, and the position in Central Europe is still very obscure. Sir Henry Rew is not greatly perturbed, but thinks that if the social and political conditions of Europe became settled, its food production would rise to pre-war level in the course of two or three years. He is also quite hopeful about the position in this country. No student of British agriculture can ever give up hope of the future, and Sir Henry Rew is one of the leaders of the helpful band of optimists.

E. J. RUSSELL.

Differential Geometry.

The Elementary Differential Geometry of Plane Curves. By R. H. Fowler. (Cambridge Tracts in Mathematics and Mathematical Physics. No. 20.) Pp. vii+105. (Cambridge: At the University Press, 1920.) Price 6*s.* net.

DIFFERENTIAL geometry is a fascinating subject, because it gives us vivid and picturesque embodiments of theorems obtained by the combination of several branches of pure analysis, such as algebra, function-theory, and the infinitesimal calculus. It presents us with problems of all degrees of difficulty, from the comparatively simple theory of curvature and torsion to the provokingly difficult question of geodesics.

The present tract is just what its title indicates, except that there are a few digressions on twisted curves and on surfaces. The work has two conspicuous merits; in applying the differential calculus, the assumptions made are explicitly pointed out, and proper attention is paid to the determination of sign. The latter point is particularly important, not only because an error in sign is the one most frequently committed in computation, but also because, if a consistent determination of sign is not strictly adhered to, the formulæ of analytical and even of pure geometry cease to have general validity. Even now our text-books, especially in analytical geometry, pay so little attention to this matter that a university teacher has to spend much valuable time on this topic with intermediate students, and too frequently finds, to his disgust, that even an honours student is not so careful as he should be in the matter of sign.

Mr. Fowler's chapters on tangents and normals, curvature, contact and envelopes, leave little, if anything, to be desired. The chapter on envelopes is the most thorough-going, and suggests a couple of remarks. The elimination of α from the equations $f(x,y,\alpha)=0, \partial f/\partial\alpha=0$ leads to a definite locus

which may break up into a number of distinct, irreducible curves. How far any one of these curves should be considered to form a part of the envelope proper depends upon our definition of "envelope." For instance, in the author's example (p. 61)—

$$(y-\alpha)^2-x^3=0,$$

the α-eliminant is $x^3=0$, which is a cusp-locus: Mr. Fowler refuses to regard this as an envelope, but if we regard the cusps as limiting forms of nodes, we may fairly regard $x=0$ as the limit of an envelope. However, this is a matter of slight importance, because each case that occurs can be treated independently.

On p. 60 we have the example—

$$\alpha^2 f+(2\alpha+1)h=0,$$

where the α-eliminant is $h(h-f)=0$, and neither $h=0$ nor $h-f=0$ is an envelope. If we put $(2\alpha+1)/\alpha^2=\beta$, the family of curves is $f+\beta h=0$, and the β-eliminant is $h=0$. It seems worth while to direct attention to this apparent discrepancy, because similar cases occur in problems of maxima and minima, etc. If, starting with $f+\beta h=0$, we replace β by $(2\alpha+1)/\alpha^2$, we obtain, by variation of α, the same pencil of curves; but, generally speaking, each curve occurs twice, and, as a rule, for different values of α. If $\beta=-1$, $(\alpha+1)^2=0$, and the curve $f-h=0$ counts twice for the double value $\alpha=-1$, and hence $f-h=0$ occurs in the α-eliminant, though it does not appear in the β-eliminant. Similar results, of a more complicated kind, occur if in $f+\beta h=0$ we put $\beta=\phi(\alpha)/\psi(\alpha)$, where $\phi(\alpha)$, $\psi(\alpha)$ are any polynomials in α.

In his last two chapters we think Mr. Fowler has rather lost his sense of proportion. In the eight pages devoted to the singular points of plane curves, scarcely anything more is attempted than a discussion of ordinary nodes and cusps; on the other hand, fourteen pages are filled with the theory of rectilinear and curvilinear asymptotes, and many of the results may fairly be said to be more interesting in function-theory than in geometry proper.

The author has conscientiously given references to the text-books which he has more or less followed in his exposition; but there is no bibliography of original papers, such as add greatly to the value of other tracts in this series. We hope that in future editions this want will be supplied; reference should at least be made to Puiseux, Weierstrass, Smith, and Halphen in connection with singular points. G. B. M.

A Garden in the Dunes.

Arcachon, Ville de Santé: Monographie Scientifique et Médicale. By Dr. F. Lalesque. Pp. viii+798. (Paris: Masson et Cie, 1919.) Price 25 francs net.

THIS handsome volume is mainly a justification of Arcachon as a health-resort, and it should appeal to those who feel the attractions of a life in France, and yet shrink from the crowd and cosmopolitan gaiety of the Mediterranean Riviera. The author is not content, however, with giving climatic temperature-charts, records of rainfall, and views of exercises on the shore and of yachting on the broad sea-basin. He has made a "regional survey" of his district, and the details of the natural history will provide matter of much interest to those who sojourn in the town. The modern "town" is a veritable garden city, especially developed in the last twenty years in accordance with Dr. Lalesque's scheme for *la cure libre*, and the separate villas provided in the *ville d'hiver* among the woods offer the patient the cheerful encouragements of family life in place of the more formal control of the sanatorium. The sand-dunes have been captured, as it were, and converted into shelters, while the fishing village on the open northern strand has been enlarged as a place for summer bathing.

Arcachon, indeed, began its career of usefulness when François Legallais, a retired sea-captain, imported from India to its desolate sand-hills the idea of the bungalow in 1823. Dr. Lalesque gives us, in a few brief lines, a sketch of this rather captivating incident in human settlement and geography. His range of vision is wide. He interests us equally in the wind-worn grains of magnetite brought northward from the great fan-deltas of the Adour system; in the "alios," a ferruginous conglomerate formed as an iron-pan in the subsoil, the permeability of which has now been triumphantly established; in the health of the oyster, an inoffensive creature, infected with typhoid germs entirely by the carelessness of man; and in the diatoms that flourish in the Lac de Cazeaux, to the actual benefit, it appears, of the water-supply of Arcachon. Dr. Lalesque in 1890 made an independent investigation of the irritating power on the human skin of the processionary caterpillar, the larva of *Bombyx pityocampa*, which inhabits the pine-trees of the coast, and he concludes that the hairs which cause urticaria are scattered from the nests of the insect by the wind. Even this affection seems trivial at Arcachon; we can imagine a visitor, temporarily inclined to irritation, being calmed by Dr. Lalesque's

enthusiasm and by his introduction to the fascinating work of Fabre.

The author shows us Arcachon, not as a modern creation on a promontory in a featureless lagoon, but as the product of great natural forces, conspiring for the health of man. The winds blow over it fraught with warmth from tropic waters; the sands are kept from wandering by the growth of aromatic pines; and the subsoils that can be traced southward across the vast Pliocene estuary of the Landes represent for the naturalist the spoils of the Central Plateau and the Pyrenees. Like Prof. Tornquist in East Prussia (NATURE, vol. lxxxv., p. 468), but with a little more professional formality, Dr. Lalesque has conquered in a field that offered little promise to the unobservant eye. G. A. J. C.

Our Bookshelf.

Iron Bacteria. By Dr. David Ellis. Pp. xix + 179 + v plates. (London: Methuen and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

IN this book Dr. David Ellis has compiled a monograph on a subject which he has largely made his own, and on which he can speak with first-hand knowledge. The group of micro-organisms discussed is important, and one of the makers of geological history, for many of the bog iron ores owe their formation largely to the activities of iron bacteria, and other iron ores may be due to the same cause. In modern life these organisms are of importance to the water engineer in relation to water reservoirs, the corrosion of conduit pipes, and the general appearance and clarity of water supplies.

The iron bacteria are a heterogeneous group of organisms, scarcely bacteria in the strict sense, belonging to several genera—Leptothrix, Cladothrix, Crenothrix, and others. The iron is collected from the water in which they live, and stored in a concentrated state as ferric hydroxide in the mucilaginous sheaths which surround their bodies. The ferruginous deposit in the membrane is often so great that it exceeds the volume of the organism itself, and the iron-impregnated membrane may persist for long after the dissolution of the organism.

Some of these organisms may occasionally multiply in a very short time to such an extent as in the course of a few weeks to change entirely the character of the water in which they are present, as was the case at Cheltenham in 1896. They may also cause encrustations in the pipes, and the group is therefore of considerable economic importance. Six species are fully described, and methods of treatment to retard their activities in water supplies are detailed. The book is well produced and illustrated, and forms a standard work on the subject.

R. T. H.

Meteorology for All: Being some Weather Problems Explained. By Donald W. Horner. With an Introduction by M. de Carle S. Salter. Pp. xvi + 184 + vii plates. (London: Witherby and Co., 1919.) Price 6*s.* net.

THE science of the weather may well make a wider appeal than any other branch of science, and the opening for a book which is not only scientifically accurate, but also simple and easily comprehended, is therefore very great. The author of the present work has realised that the opening exists, and has endeavoured to fill it, but his attempt can scarcely be considered successful. A few quotations will illustrate the nature of the book. In estimating cloud amounts on the scale 0–10 we are told that "if there is one cloud upon the horizon or in any part of the sky we put 1." For obtaining true bearings from a compass, "the magnetic variation in the British Isles is now 14° W." Again: "There is no more sure precursor of a gale than the 'wind-dog,' or coloured parhelion" (p. 2), which may possess some degree of truth, but scarcely seems compatible with: "When these halos are coloured and accompanied by parhelia or mock suns, they generally precede very dry weather" (p. 110). Even in such a simple matter as giving the equivalent velocities of the Beaufort numbers, the author falls into error. Some chapters are better than others, but the book can certainly not be recommended as a safe guide to put into the hands of the non-technical reader without previous knowledge of meteorology. J. S. D.

The Psychology of the Future. (*"L'Avenir des Sciences Psychiques."*) By Emile Boirac. Translated and edited with an introduction by W. de Kerlor. Pp. xiii + 322. (London: Kegan Paul, Trench, Trubner, and Co., Ltd., n.d.) Price 10*s.* 6*d.* net.

THE author deals with the more debatable classes of psychical phenomena discussed at the Paris Congresses of Experimental Psychology of 1911 and 1913, and defined as "the phenomena which, produced in animate beings or as an effect of their action, do not seem to be entirely explicable by the laws and forces of nature already known." They are classified as: Hypnoidal, including dissociation of personality and "cryptopsychism" (subconscious action); magnetoidal, which are supposed to comprise mesmerism, telepathy, and "hyloscopic" phenomena (unexplained actions of inanimate objects on animate beings); and spiritoidal, which imply agents of a psychological nature more or less analogous to human intelligence. The author proposes the term "biactinism" (bio-actinism?) for any phenomena in which a radiating influence is apparently exerted at a distance over other animate beings. For "clairvoyance," or knowledge obtained by certain individuals apparently independently of the normal senses, he prefers the term "metagnomy." On the question of the spiritistic hypothesis the author maintains a non-committal attitude.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Indian Chemical Service.

IT would, perhaps, have been better if the writer of the leading article entitled "The Organisation of Scientific Work in India," published in NATURE of February 19, had held his hand until he had obtained further information concerning the proposed organisation. The report of the Indian Industrial Commission dealt only with the general question, and left the elaboration of any scheme, if such were considered desirable, to special committees which were to be appointed at a later date. The special committees were to be given a free hand, and were left to approach the problem from an unbiassed point of view.

I was not a member of the Indian Industrial Commission, but there is nothing in the report which indicates that the Commission was in favour of a centralised system of scientific services under Government control such as that which is condemned in the article, and still more emphatically condemned by those who have contributed to the ensuing correspondence. As a matter of fact, if the Industrial Commission had recommended such a course, it would not have been supported for one moment by the Chemical Services Committee, over which I had the honour to preside. Indeed, my colleagues and I, as old investigators, would have been fully alive to the absurdity of any such proposal.

I should like to make my position clear by referring to the conditions we found to prevail in India and to the remedies which we considered necessary in order that the great natural resources of the country might be developed, but I should preface my remarks by saying that I speak for chemistry alone. Other sciences must formulate their own schemes in a manner best suited to their particular requirements.

The problem presented was twofold: First, the position of the chemists in India, and, secondly, the position of the Indian chemical industry. The position of chemists we found to be exceedingly unsatisfactory. There are in all about fifty chemists in India, and most of them are attached to established Government Services, such as forestry, agriculture, medicine, geology, ordnance, and education. In the main, the chemists, although working in the Services, were not attached to them—that is to say, they were in the position of hirelings without any claim to the advantages attaching to Service membership and without the possession of the *esprit de corps* which characterises such membership. They were, moreover, for the most part working in isolated positions in the different provinces, and were without any means by which they could press their claims on the official lay mind. In consequence, they were in many cases receiving totally inadequate salaries, and were, in fact, often regarded as some kind of freak druggist—a point of view which is even more prevalent in India than in England. It was clear that the only way by which the chemist in India could be brought to occupy a financial and social position which his education and training demanded was to place him on an equality with members of other Government Services.

The problem of the chemist was therefore a straightforward one, and was, in our opinion, open to one answer only. The other point, that of the Indian chemical industry, is perhaps rather more complex.

In the first place, there can be no question, I think, that research in chemistry must be divided into pure research and industrial research. It is true that there is no sharp line of division, but in their extreme forms pure research is carried out entirely for the advancement of knowledge, and is without obvious practical bearing, whereas industrial research is done for the advancement and development of industry. The Chemical Services Committee has recommended that pure chemical research should be left to the universities and university institutions, the obvious duty of which is to carry it out. It is not proposed that the chemists attached to university institutions should be normally members of the Service, but it is asked that the universities and university colleges should undertake to train men for recruitment into the Service in the manner recommended by the Committee.

The Committee considers that recruits should have the following training:—

(1) An honours degree in chemistry in the first or second class or its equivalent.

(2) Training in engineering (machine drawing and workshop practice) where such training has not formed part of the course under (1).

(3) One or two years' training in the methods of chemical research under someone competent to train in research.

It is not proposed to institute any system of training within the Service, excepting, of course, such practical training as will normally accrue during the working of the Service, and it is asked that the universities and university institutions should give the necessary training under (3) above. For this purpose it is recommended that maintenance and equipment grants should be given to promising students to enable them to undergo this training subsequent to graduation.

The Committee considered that, provided the trainer were a man of recognised ability, the question of the subject in which the student should be trained could be safely left to him. It agreed that instruction in the methods of chemical research, received after a course such as that given above, was the best training a man could have to develop any initiative and enthusiasm which he might possess, and that a man so trained ought to be able to turn his hand to anything chemical.

In the case of industrial research it must be remembered that chemistry in one form or another underlies most industries, and that in India the following conditions are present: (*a*) Great natural resources; (*b*) lack of scientific chemical help to develop these resources; and (*c*) a public very shy to risk capital without some real assurance of the value of the process it is proposed to finance.

Obviously, the best means for advancing chemical industry is for the firms or combination of firms engaged in the industry to establish research laboratories and to work out their own problems by the aid of their own chemists. This is an ideal which the Indian Chemical Service will be formed to foster. It will, for example, help any member of the Service who wishes to pass out into the industry, and it will second members of the Service for temporary employment to firms who wish to investigate any particular problem. But at the present time there are few manufacturers who employ chemists, and it is evident that some steps are necessary not only to demonstrate to the manufacturer the value of research in connection with his manufacture, but also to demonstrate the possibilities of any particular process to anyone wishing to invest capital and start a new industry.

Who is to do this? There is, we think, only one answer, namely, that, as it is to the interest of the State as well as of the manufacturer to develop

industry, it is the duty of the State to convince the manufacturer of the value and necessity of research in connection with his work.

The Indian Chemical Service will have research institutes in the centres of industry of every province. These will be in close touch with the works and with works conditions, and deal with questions of immediate practical importance submitted by manufacturers. They will also carry out research work in connection with the establishment of new industries, and develop a process as far as the unit factory scale. In some cases it will be necessary, in order to demonstrate the value of a process, to erect pioneer factories and work them on the complete commercial scale. Each institute will be under a director of research.

A central Imperial institute will be located at Dehra Dun. It will be under the Director-General of the Chemical Service, and contain laboratories for inorganic and physical chemistry, organic chemistry, analytical chemistry, and metallurgical chemistry, each controlled by a deputy-director. Questions involving fundamental research arising out of the work of the provincial institutes will be dealt with here, as well as the initial work in connection with the establishment of new industries. Research work of an All-India character, such as investigations on the utilisation of forest products, will also be done.

The report, which should reach England during the course of the next fortnight, should be consulted for further details. It may be added, however, that there is no official control; the Service will be worked by chemists for chemists. Chemists seconded for service with other Departments will retain their lien on the Chemical Service, but be under the control of the Department to which they have been seconded.

The provincial institutes will not be under the control of the central institute, which will act towards them in an advisory capacity only.

In conclusion, I should add that I have discussed the proposed scheme with eminent Indian men of science and prominent business men in different parts of the Empire, and they have told me that they are prepared to give it their whole-hearted support. Moreover, Sir P. C. Ray, the distinguished professor of chemistry in the College of Science, Calcutta, who was a member of the Committee and attended all its meetings, while stating at the outset that he was opposed in principle to Government Services generally, nevertheless agreed to each paragraph of the report as it was passed in its final form. He signed the report subject to a separate note in which he expresses his general approval of the scheme in the following words: "In conclusion, I desire to state that, although I consider that the days of Government Services are over and that the development of industries by the agency of a Government Service is not the most suitable way of dealing with the problem, yet I agree that, if a Government Service is constituted, the proposals of the Committee represent the best method of constituting and carrying on such a service. It is for this reason that I have attached my signature to a report with the major portion of which I am in substantial agreement."

JOCELYN THORPE.

I HAVE followed with keen interest the leading article on "The Organisation of Scientific Work in India" in NATURE of February 19, and the correspondence thereon by Profs. Soddy and Bateson, Sir Ronald Ross, and others. The note of warning has been sounded not a moment too soon. To me it appears that the Industrial Commission has not been able to make out a very convincing case for the creation of a highly expensive All-India Chemical Service—an elaborate and ordered hierarchy under the almost absolute control of a number of highly paid bureaucrats. The Services degenerate in India, the land of caste, into so many rigid and watertight compartments unamenable to healthy external influence.

The manner in which the work of the Service is to be carried on appears to me to be extremely objectionable. There is to be a Director-General of Research at the Imperial Chemical Institute, with five or six directors at different provincial centres. These officers are to have almost absolute power over the rank and file—the real workers; for not only are the directors to dictate what particular piece of research a worker is to take up, but even the publication of the work is to be subject to the consent of the Board of Control.

For the scheme to be successful the directors must be men who are conversant with almost all the different branches of chemistry, and keep in touch with the most up-to-date advances in their science. Moreover, their minds are to be occupied with swarms of problems awaiting their day to be delivered to the care of the researchers. Lastly, they are to do justice, with the impartiality of a Privy Council Judge, to each individual worker according to his work and accomplishments. Even the greatest chemists of the age would hesitate to acknowledge that they are supermen of this description.

I am afraid that the proposed Service will simply be an asylum for a few officials in favour with the Government who find administrative work much more suited to the taste than bottle-washing and other humdrum work of the laboratory, and want to legalise the exploitation of the brain and labour of the young men just coming out of the universities full of new ideas and enthusiasm for work. We shall have a number of chemists working under a peripatetic director whose claims to the post will be his seniority, which in India often goes hand in hand with incompetence. I am afraid that the so-called research work will lapse into dull, mechanical, routine outturn, and will kill all enthusiasm and initiative on the part of the actual workers. They are even, as Prof. Soddy remarks, "to be deprived of what little satisfaction and independence genuine scientific work for its own sake affords," and in many cases will have to renounce their own work for the propitiation of the directors.

It seems to be supposed that since there is a Viceroy over governors, a governor over a number of magistrates, and a magistrate over a number of petty officials, so there must be an Imperial chemist over a number of provincial directors, directors over deputy-directors, deputy-directors over sub-deputy-directors, and so on. But in the republic of science the idea of such ordered gradation is absurd. Each branch of science, notably chemistry, has now grown so vast that a particular worker, however highly gifted, can honestly tackle and follow intelligently the developments of only a minute fraction of his subject. In the quest after truth and in the exploration of new paths of knowledge every worker has to find out his own way, and it not infrequently happens that a young and unknown worker may achieve much more brilliant results than men who have grown grey in the service of science. What is wanted is co-operation, provision for more ample facilities, and the opening up of better prospects for the earnest-minded and enthusiastic workers.

In India at the present state of her scientific development, the institution of the Chemical Service on the proposed lines will be not simply a blunder, but

a crime. There is not a single technical teaching institute in the whole of India. In the universities and Government colleges there is very meagre provision for research work. The universities are just trying to emerge from mere examining bodies into centres of education, and the demand for State aid for founding chairs in experimental and industrial subjects is very great. In Bengal, the most advanced province in India, there are, technically speaking, no endowed chairs at all (except one or two founded by the generosity of patriotic citizens). Altogether we have five or six high posts in the Government colleges, but the occupiers of these posts are required only to teach, and not to do any research work. The number of research scholarships is only three or four. But the man who has done good original work, and has the good fortune to be taken into the Service, has no better prospects before him than the man who has nothing to his credit except his original degree in the university; for under the Service system promotion is by favour and seniority, not by work and efficiency.

It appears to me that the most pressing needs for India at the present moment are: (1) The foundation by the Government of a number of chairs in various branches of pure and applied chemistry in the universities, and also a large number of readerships, assistant professorships, and research scholarships. (2) The establishment of a number of technical institutes and the strengthening of the laboratories and scientific libraries. (3) The organisation of the posts so created and of the posts already existent on a professional rather than on a Service basis. (4) The replacement of the director by boards of recruitment composed chiefly of university professors, one official, and one or two non-official representatives of the public. (5) The encouragement of the foundation of scientific societies.

There should be no watertight separation between those who are engaged in special types of work in Government research institutes and those working in the university laboratories. The officials in the research institutes should be asked to maintain a life-long connection with the university in some shape or other; and the researchers in the universities may be invited, when an occasion arises, to avail themselves of the opportunities afforded in the research institutes.

PRAFULLA CHANDRA RÂY.
University College of Science, 92 Upper Circular Road, Calcutta.

The Cost of Scientific Publications.

IN the timely leading article in NATURE of May 6 on the cost of scientific publications a note is struck which goes deep to the heart of many scientific workers—editors, secretaries, and members of councils on one hand, struggling to make inadequate funds meet the greatly increased expenses, and on the other the young investigators whose papers on the results of research are being held up by the impossibility of paying for publication. It is difficult to see the remedy at the moment. Most of us will, I think, agree with you that increased subscriptions to the publishing societies, on any adequate scale, would be a hardship to many, and probably defeat the end in view by choking off members. My experience as an officer of the British Association and of several scientific societies has shown me that it is difficult enough for our younger scientific workers, such as the demonstrator class at the universities, to afford the necessary expense of joining such societies and attending the meetings. Recognising the great pleasure and advantage that one enjoyed in seeing and hearing the senior men in the subject at the first scientific meetings one attended (British Association and Linnean Society), it would be deplorable that anything should be done to render it still more difficult than it is for the younger men of to-day to attend and take part in such gatherings.

You suggest that we may have been unduly extravagant in the past in the production of our scientific publications. This may have been so to some slight extent in a few cases, but I am by no means convinced that it is general, or material, and I would deprecate any drastic change. A judicious and kindly editor, secretary, referee, or communicator of a paper may usefully do something to moderate the exuberance of a youthful author and to keep note-book details within reasonable bounds; but the scientific value of a paper may be spoilt by ruthless excision. It is not enough, in many cases, to give end-results unless conclusions are to be accepted uncritically like text-book statements. To be of value to workers on the subject in the future, the details of experiments and the statistics of observations are essential. I see therefore no remedy except the provision of considerably increased funds for publication, not from the members of the publishing societies, but from outside sources—either private benefactors or the State.

We already have certain endowments and certain annual grants for the promotion of scientific research, but I would urge the emphatic opinion that adequate publication is an essential part—the necessary completion—of any important and successful research. Some administrators of scientific funds—for example, the trustees of the Percy Sladen Memorial Fund—have acted on that view, and so far as their limited resources allow they try to see through to complete publication the researches which they have supported; but, of course, this limits to some extent their activities in subsidising further research.

The provision of a considerable endowment from which grants might be given in aid of the publication of worthy papers by the principal scientific societies would be a noble benefaction which would doubtless have an effect upon the advancement of knowledge second only to the endowment of the research itself.

W. A. HERDMAN.
The University, Liverpool, May 9.

I HEARTILY agree with the opinion expressed in the leading article in NATURE of May 6 that a Government subsidy is necessary at the present time to lessen the sudden shock of war conditions to our scientific societies, especially in the matter of printing. The case was well put by Sir Joseph Larmor in a letter to the *Times* some months ago: the blow strikes at the very roots of scientific advance, and the risk of vital damage is thus the greater because roots are apt to be buried out of sight. If the mischief be not remedied in time, it will become clearly manifest only when the fruits begin to fail.

In societies with which I am connected, and especially in the British Association, anxious study has been made of all possible economies in printing, and anything which could be regarded as a luxury is being rigidly excluded; but the printing bill will still be heavy—much heavier than before—and the excess will inevitably be subtracted from funds formerly devoted to research. Moreover, we cannot be quite easy about the omission of the items regarded as luxuries. It is a common experience that life-long influences may hang on trifles, and the natural accretions which gather round an old-established association like the British Association are peculiarly liable to contain just

the trifles which may decide events. The scientific net can scarcely be cast too wide.

H. H. TURNER.

University Observatory, Oxford, May 8.

THE appearance of the leading article in NATURE of May 6 is extremely opportune. The question is one in which the scientific world is seriously concerned, and the possibility of the high cost of production stifling the progress of science must lead us to consider what means can be found to obviate so disastrous a calamity. It is unnecessary to quote evidence of the enormous increase in the cost of printing and publication at the present time—that is well known—but the question is accentuated by many indications that the cost will go higher in the near future.

It is very undesirable that such increased charge upon the funds of scientific societies should be met by raising subscriptions. No deterrent to join societies should be advocated, for science is advanced more by individuals than by the extent of their published papers.

The question turns upon the limitations which the present state of affairs must exercise upon publications. It is quite certain that some curtailment is necessary to avoid insolvency. It is patent to all that many papers are characterised by diffuseness and redundancy, as if the value of a paper was to be judged by its length. No one who wishes to keep *au fait* with current work has time to read such—conciseness and economy of expression in the treatment of scientific papers are the desiderata.

During the war we were rationed in our food for the body, with good rather than harm to ourselves. It is now necessary that the food for our minds should be rationed. The only possible way to carry on until things are easier is to limit publication to condensation or abstracts of papers, except in special cases. It is not an easy task to make abstracts of papers so as to retain all that is essential, and with some writers it is extremely difficult to condense their diffuse communications. The point might be met by putting the responsibility upon authors and limiting them to a definite number of pages, according to the character of the paper.

Let me give an instance where curtailment in publication has resulted in great economy without loss. A few years ago the volume of Greenwich Observations extended to as many as 1400 pages. The Board of Visitors decided that it was not necessary to publish a considerable mass of observations, as these could always be supplied from the Royal Observatory to anyone who wanted them, and by this means the volume was at once cut down to less than 600 pages.

E. B. KNOBEL.

32 Tavistock Square, W.C.1, May 8.

THE leading article in NATURE of May 6 comes home to those of us who are concerned in carrying on the work of scientific societies. We are making laborious efforts to prune down diffuse contributions, and also endeavouring to increase our income by attracting new members. Many of us regard an increase in subscription rates as a device only to be contemplated as a last resort, and are in complete agreement with your article.

The Royal Meteorological Society is directly concerned with the question of accommodation, as well as of increasing costs of publication, and we should welcome any possibility of joining the privileged societies that are housed by Government. Failing a cash subvention for the one purpose, is it possible to urge the Government to do something for us in the other direction? I should like to press for the removal of the Civil Service Commission from Burlington Gardens. Examinations might well be held in university rooms at South Kensington or elsewhere. I do not know how many societies could find adequate room in the building if it were thus set free; but it seems to me that assistance of this kind would be, at any rate for those of us who secured it, better than a subvention towards printing expenses, and possibly easier to obtain from the Government.

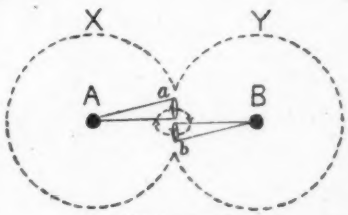
WALTER W. BRYANT,

Hon. Sec., Royal Meteorological Society.

Royal Observatory, Greenwich, S.E., May 8.

Atomic and Molecular Forces and Crystal Structure.

ONE of the most difficult problems in the theory of chemical valency is to form a clear picture of the attractive forces between *similar* atoms. Lewis and Langmuir, in their theory of the cubical atom, have each attributed the single valency bond to the mutual action between a pair of electrons, and Langmuir has recently pointed out (NATURE, April 29, p. 261) that, as regards chemical considerations, such a pair of electrons may be regarded as revolving in the same orbit. This idea is closely allied to Bohr's construction for the hydrogen molecule. It should, however, be pointed out that such a construction leads to a strong paramagnetic property for molecular hydrogen, unless the electron motions are compensated by rotation of the nuclear charges. Such compensation is scarcely likely, since the magnetic moment depends on the area of the orbit described, and evidence up to date points to a nuclear radius of small order compared with that of the electron orbit, even though the latter be small compared with the conventional radius of the atom.



Model of hydrogen molecule.

Suppose X and Y are two exactly similar hydrogen atoms. Their nuclei are shown at A and B, and the negative electron orbits at *a* and *b*. The nucleus A may control the orbit *a* electrostatically and magnetically, while B controls *b*. As shown, there will be magnetic attraction between *a* and *b*, and possibly also a certain amount of electrostatic repulsion if each electron is not completely bound to its own nucleus. Equilibrium may be established for some such disposition of the charges as that indicated. We thus get a sort of fusion of the two hydrogen atoms which corresponds to the fusion of the electron orbits in Bohr's theory of the hydrogen molecule. In the present case, however, the fusion is controlled magnetically, whereas in Bohr's theory it is purely electrostatic.

The system depicted above gives a diamagnetic hydrogen molecule as required.

With more complicated systems, we can see, in a general way, how the small circular orbits will dispose themselves in pairs (Lewis and Langmuir) primarily under their mutual magnetic influences.

We might further expect that the crystallographic symmetry would be determined in a similar way by the magnetic forces due to the electrons in each atomic kernel. These electrons are drawn by mutual magnetic forces into a *space-pattern*, characteristic for each molecule, and the symmetry of this pattern is reflected in the crystalline symmetry. Thus the rigidity of the crystalline medium in different directions and the orientations of the planes of cleavage are defined in terms of the local magnetic forces (*cf. Science Progress*, No. 56, March, 1920, p. 588; Phil. Trans. Roy. Soc., vol. ccxx., A, p. 247, 1920, particularly conclusion xii., p. 289; vol. ccxv., A, p. 79, 1915; vol. ccxiv., A, p. 109, 1914). The close connection between the deportment of crystals in a magnetic field and the disposition of the planes of cleavage, as observed by Tyndall, may then be explained.

Possibly each of the electron orbits shown in the above diagram may be identified with the ring-electron of A. L. Parson (Smithsonian Miscellaneous Collections, vol. lxv., p. 1, 1915). The conception of the hydrogen molecule and the line of argument leading up to it, as indicated by the above papers, are, however, quite distinct from those described by Parson.

A. E. OXLEY.

The British Cotton Industry Research Association, 108 Deansgate, Manchester, May 1.

Wasps.

If glory be known to insects; if solid glory be measured among them, as among us, by the difficulties surmounted, the female wasp is a heroine to whom the queen bee is in no way comparable.—RÉAUMUR.

HAVING spent some time in observing wasps during the past eight years, a few notes descriptive of the results may possibly have an interest at this season when the queen wasps are searching for suitable positions in which to found new colonies. The queens usually appear in the third or fourth week of April, and about a fortnight later than the humble bees. They spend a few days in feeding, and then fly about grassy banks and hedgerows, looking for a mouse's hole or some fissure or opening in the ground likely to prove desirable habitations. They are very fastidious in making a selection. I have specially constructed places for them, but hundreds of queens have declined the invitation. In twenty-seven cases, however, the queens took up residence, and the average date was May 6. The young wasps begin to show themselves in twenty-nine or thirty days, and then a few days later the queen remains at home. During the month elapsing before the small working wasps appear the queen works hard, and performs about 1136 completed journeys to procure material for constructing cells and obtaining food for herself and young. The number given is the mean derived from eight nests.

When a queen finds herself a proper site in which to build, it by no means follows that she will succeed in rearing a colony. Only one in three have overcome the difficulties (*i.e.* nine out of twenty-seven) in my garden, for trouble was occasioned by marauding intruders such as ants, earwigs, beetles, woodlice, etc. Besides, every man's hand is turned against the wasp, and numbers of queens are destroyed every spring before the embryo nests have developed.

As to the number of wasps composing a nest, this varies greatly. The strength is pretty fairly indicated by the number flying to and fro, and I have generally kept a record of the horary rate. In regard to three strong nests, the following were the figures on different dates, a wasp flying out being counted as one, and one going in as one, so that completed journeys would be half the figures given:

Date			Two nests in 1915. per hour	One strong nest in 1918. per hour
June	25	... ...	150	742
July	5	... ...	350	1,750
	15	... ...	670	4,800
	25	... ...	1,250	7,230
Aug.	4	... ...	2,560	8,400
	14	... ...	3,900	11,150
	24	... ...	5,200	12,060
Sept.	3	... ...	6,800	15,780
	13	... ...	4,500	6,860
	23	... ...	2,150	3,030
Oct.	3	... ...	1,250	1,620
	13	... ...	650	280
	23	... ...	250	very few

In September, 1918, I recorded an abnormal rainfall of 10·47 in., and this occasioned the virtual swamping of the nest I kept under observation in that year.

With regard to young queens, they begin to leave the nests at different times. In 1913 I noticed them first on August 21, in 1916 on August 19, and in 1918 on September 22. Two nests not at all abundant yielded in one case 990 queens and drones, and in the other 1400. A strong nest in 1915 yielded in all 1118 queens and 995 drones. There were ten tiers of cells in another nest, and six of the largest measured 10×8 in. These included 12,900 cells at least, and if each cell produced three generations this means an aggregate of nearly 40,000 wasps.

The most prevalent species of wasp in this locality is *Vespa germanica*, in the proportion of 3 to 1 of other varieties. Of twenty-seven nests, I had 1 *V. rufa*, 7 *V. vulgaris*, and 19 *V. germanica*. The latest colony I have seen in great activity was on November 5.

Wasps kill an enormous number of flies of all kinds. I found that the members of a moderately small nest of *V. germanica* in 1913 brought home at least two thousand flies per day. A very strong nest would account for twelve times as many. Man often misapprehends the benefits derived from certain forms of animate Nature. Birds are destroyed and noxious insects enabled to multiply. Efforts are ever being made to exterminate the wasp, and hordes of pestiferous flies naturally become the bane of our summers.

In spite of the popular belief, wasps are not nearly so bad-tempered and dangerous as they are supposed to be. If not obstructed or attacked they are quiet and harmless enough, and may be watched with entertainment. They are most industrious. Sir John Lubbock (later the first Lord Avebury) said: "I have been much struck by the industry of wasps"; and "On the whole, wasps seem to be more clever in finding their way than bees." Mr. T. A. Preston in the Phenological Report for 1887 (Royal Met. Soc. Journal, vol. xiv., p. 56), speaking of the wasp, stated: "It seems far superior in intelligence to the bee."

W. F. DENNING.

Dr. J. G. Bartholomew and the Layer System of Contour Colouring.

To prevent misapprehension, it would have been better if, in the sixteenth line of the obituary notice which appears on p. 238 of NATURE for April 22, the word "introduced," used by Dr. Bartholomew himself in "Who's Who," had been employed instead of "devised." Dr. Bartholomew made no claim to be the originator of the idea of indicating differences of altitude by differences of colour, but he was the first to apply this method to topographical maps.

GEO. G. CHISHOLM.

The Prismatic Astrolabe.[1]

IN the process of measuring the places of stars on the celestial sphere, or in the converse process of using these measured places to fix the position of the observer upon the earth's surface, the astronomer has at his disposal two systems of reference lines or circles upon which to base his measurements. These are respectively the vertical great circles through his zenith and the small circles parallel to his horizon, the circles of equal altitude or equal zenith distance. Using the first system, his method is to time the transit of a star across a vertical circle, almost invariably the meridian circle passing through the north and south points. If, in addition to timing the transit, he measures the altitude, he gets a complete determination of the position of the star observed, and uses both sets of reference circles, the vertical circle for fixing the time of transit, and hence the right ascension of the star, and the horizontal circle for fixing the altitude of transit, and hence the star's declination. This is the ordinary observation carried out in the observatory with the transit circle or by the surveyor in the field with the theodolite. Another method of observation which gives the same quantities, though not in the same direct form, is by the use of an instrument adapted for the recording of transits across a horizontal circle of constant altitude. An instrument of this class is the almucantar, in which horizontality is secured by the device of floating the whole in a mercury bath, it being easily seen that if either the instrument or the bath is moved round, the telescope will maintain a constant angle with the horizontal, and the line of vision will therefore always intersect an almucantar or circle of equal altitude.

Another instrument of the same fundamental type, but of an entirely different form, is the prismatic astrolabe devised about twelve years ago by MM. Claude and Driencourt. This appears to possess great merits for survey work in the field, and has earned quite enthusiastic praise from those who have used it. The one objection to its more extensive employment, the arduous labour involved in preparing observing lists of stars, has now been removed by the publication of Messrs. Ball and Knox Shaw's "Handbook" and "Diagram." We will revert to this point later, but we must first give a short description of the principles of this interesting instrument.

It consists essentially of a telescope with a 60° prism in front of the object glass, and a mercury trough placed so as to reflect the star on to the lower face of the prism.

The prism can be placed in either of the two positions shown in Fig. 1, from which it will be obvious that in both cases, on looking through the telescope at a star which is approaching and near to the altitude of 60°, two images of the star will be seen moving towards each other, and that these images will coalesce into one when the apparent altitude of the star is equal to the angle of the prism. In arrangement A the reflection is from the two outside surfaces of the prism, which must therefore be silvered; in B we get a total reflection from the two inside surfaces. It is further obvious that with outside reflection the angle of the prism can be given any value; the two star images will always coincide when the altitude is equal to this angle, whereas if the rays traverse the glass they must enter and leave normal to the faces; the prism must therefore be equilateral, and stars can be observed only at the fixed altitude of 60°. The observation consists in the timing of the moment of coincidence of the two images. To allow them actually to coincide would, however, render accurate timing difficult, and far greater precision is obtained by giving the telescope a very small lateral displacement, so that the images pass close to, but not exactly over,

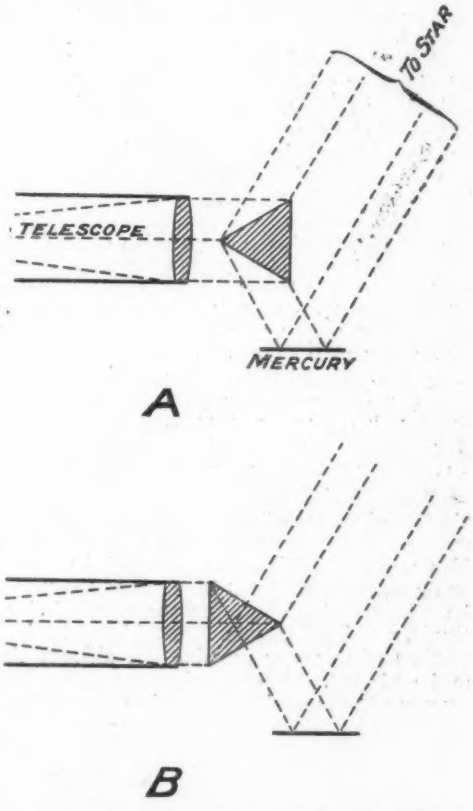


FIG. 1.—Principle of construction of the prismatic astrolabe.

[1] "Description et Usage de l'Astrolabe à Prisme." By Claude et Driencourt. (Paris: Gauthier-Villars, 1910.)
"Bestimmung fundamentaler Sternörter aus Höhendurchgangsbeobachtungen." By R. Trümpler. Nachrichten der K. G. der Wissenschaften. (Göttingen, 1913.)
"A Handbook of the Prismatic Astrolabe." By John Ball and H. Knox Shaw. (Cairo: Government Press, 1919.)
"Astrolabe Diagram." By John Ball. (Cairo: Government Press, 1919.)

each other; what is observed is, then, the transit of the two images over the same line of a horizontal graticule.

There is no appreciable difference in precision between the two prism arrangements. B has the apparent disadvantage that a closer adjustment of the telescope is required, the line of collimation must be perpendicular to the prism base, and the latter must be truly vertical, whereas with A the horizontality of the telescope and the symmetrical inclination of the prism faces are immaterial. On the other hand, from the practical surveyor's point of view, the use of the easily damaged silvered faces is inexpedient, and the method of internal reflection preferable. The disadvantages attaching to the necessity of more careful adjustment of telescope and prism are, moreover, more apparent than real. It must be remembered that while the actual observation involves no reading of graduated circle or micrometer, a horizontal circle is required for the purpose of directing the line of sight, so that the desired star will cross the field. The telescope and circle must therefore be levelled and adjusted as with a theodolite, and the extra labour involved in the setting of the prism is a very small matter.

As already stated, the preparation of an observing programme involves somewhat lengthy computations. These have now been made, and are available for the use of observers within a wide range of latitude. The "Handbook of the Prismatic Astrolabe" gives a succinct description of the smaller survey form of the instrument, its construction and method of use, and contains tables of all the Nautical Almanac stars down to the fourth magnitude which cross the altitude circle at azimuths suitable for observation for each degree of latitude between 55° S. and 55° N. This list gives sufficient stars for all field work except geodetic survey of the first order, for which more and fainter stars would be wanted. For these, reference must be made to the "Astrolabe Diagram," giving, for the same limits of latitude, a series of graphs from which the azimuth and time of any star crossing the altitude circle can be plotted. A comparison of the relative accuracy of the astrolabe and other survey instruments seems to indicate that it is probably capable of somewhat greater precision than a theodolite of similar telescopic power; and there is no doubt that in it we have a valuable addition to the resources of the surveyor. It cannot, however, take the place of the theodolite, being capable of determining only latitude and time, not azimuths or angles. It has therefore been urged as an objection to its more extended use that as a survey party must in any case carry theodolites the astrolabe could be taken only when the added labour of transport is unimportant. Apart from the fact that the addition of thirty pounds to the baggage of a survey expedition would be found burdensome only in quite exceptional cases, this objection does not appear to have any validity. A theodolite is capable of conversion into an astrolabe by the addition of the prism and mercury trough, and it would be easy to design these so that they could be clamped on to the front of the telescope, and the prism levelled in a minute or two. The extra weight would then not exceed a few ounces.

An attempt has been made, not, however, yet carried very far, to develop the use of this instrument for the astronomical problem of the determination of star places of high-order precision. It is very doubtful if it presents any real advantages for this work. The difficulty of making true plane surfaces is well known, and in an instrument of large aperture and high magnification the inclusion of flat reflectors in the optical system is undesirable. Furthermore, the two star images are not symmetrical, each being formed by only half the object glass, and the results show a magnitude equation, or variation with the brightness of the stars observed. This has not been specially studied in the portable survey patterns, but would probably be found even with them. Trümpler (*loc. cit.*), using an aperture of only 4·7 cm. and a focal length of 50 cm., found it conspicuously. It would increase rapidly with increase of aperture. For the present we must regard the astrolabe as a surveyor's instrument, capable in his hands of useful service, and leave any possible application to observatory work for further investigation. E. H. H.

The Heart of a Continent.[1]

By DOUGLAS CARRUTHERS.

"CENTRAL ASIA" used to conjure up in the imagination thoughts of lonely and mysterious frontiers between three great Asiatic Empires, of strange doings in unheard-of valleys on the Pamirs, of long-dead conquerors, and of strange capitals at the back of the world. Even now, in 1920, the heart of Asia is a storm centre, for it forms the meeting-place of the civilisations of the remote past—China; of the present—Great Britain; and of the future?—Bolshevism.

Great happenings have been in middle Asia—unheard-of movements, unimagined miseries—during the past six years, when all men's thoughts have been concentrated on Europe and the Middle East. The remote highlands and deserts of Asia did not escape the turmoil. The most secluded and most apathetic native races felt the ripples of the storm in Europe. The confines of China, India, Russia, and Afghanistan have returned, by a strange coincidence, to their former place as, what may well be, the centre of a prolonged struggle, *not* between East and West, but between right and wrong.

Chinese Turkestan, or Kashgaria, is that

[1] "Through Deserts and Oases of Central Asia." By Miss Ella Sykes and Brig.-Gen. Sir Percy Sykes. Pp. xii+340. (London: Macmillan and Co., Ltd., 1920.) Price 21s. net.

part of middle Asia which forms the most westerly province of the Chinese Empire, under the title of Hsin-Chiang, or the New Province, for it is of comparatively recent occupation (since Keen-Lung, 1758). Although an integral part of the Celestial Empire, it is actually Central Asian in physical features, character, and inhabitants. This desert plain is girt on three sides by great mountain walls, yet these barriers seem to be less of a hindrance to man than is the endless desert zone which cuts it off from China proper. The Chinese rule, but the natives look to Mecca, not to Pekin, and trade with Moscow and Peshawar rather than with the cities of China. The oases belong to the group which extends from Khotan, in the east, to Bokhara, in the west.

Chinese Turkestan, then, is a colony where mild and unwarlike farmers, probably the most phlegmatic of all peoples in the world, are ruled by a handful of Chinese officials. On the north and west was a great and virile Russian Empire ever ready to overflow still further eastwards and southwards, while on the south great mountain walls arose behind which ruled the Emperor of India. Kashgar, the capital, was the only place in Central Asia where Great Britain maintained a representative. From the Caucasus to Siberia, and from Siberia to China proper, we had no official residents. It was to this far-off city that the authors went in 1915, Sir Percy Sykes to act for Sir George Macartney, the Consul-General, on leave.

We have a general account of the journey out, by way of Norway, Sweden, and Finland, Petrograd, Moscow, Tashkent, and Osh, followed by chapters on life at the British Consulate, around Kashgar, and trips to the Russian Pamirs and to the great oases of Yarkand and Khotan. These chapters, by Miss Ella Sykes, are ably supplemented by her brother's (Sir Percy Sykes) section, which deals with the geography, government, and commerce of the district, and also gives us an historical sketch which is admirable in its brevity and conciseness, for it covers in three short chapters a period from somewhere about the third century B.C. up to 1915! It should be realised that Turkestan history was shaped by Hun, Chinese, Turk, Arab, and Mongol, while the romantic names of Kutayba, Jenghiz, Tamerlane, Amursana, and Yakub Beg figure largely. Sir Percy Sykes traces the story right up to the year of his visit, and by no means the least interesting part is that which deals with the modern period. His final sentence contains much of import: "The future of Chinese Turkestan is not finally settled, but the World War, which has temporarily broken up the Russian Empire, will undoubtedly stimulate China to move along the path of progress. If so, there is hope that the condition of this outlying province of her Empire may benefit, more especially by improved communications. At the same time, there are many parts of Asia which have reason to envy the peace and plenty enjoyed by the inhabitants of Chinese Turkestan." The chapter on "The Kashgar Farmer" is noteworthy; it shows the difference between this desert land and others. Whereas other arid regions are dependent on scanty and uncertain rainfalls, the great oases of the low, hot plains of Turkestan live by a sure and abundant water supply brought down from

FIG. 1.—A hunting eagle. From "Through Deserts and Oases of Central Asia."

the giant glaciers and snowfields which wall them in on north, south, and west. A certain livelihood, an ample and cheap food supply, and complete safety have produced a contented race, devoid of ambition and easily ruled. The townsfolk are much the same. Kashgar and Yarkand are still great trade centres. Since Marco Polo's day, "from this country many merchants go forth about the world on trading journeys." The old silk route ran the length of the country. All trade between China and Western Asia passed through Kashgar.

The volume ends with an account of a visit to the Russian Pamirs. For a long time the "Roof of the World" has been a forbidden land to the English hunter, but the war proved that Russian designs on India were a bogey. The author was permitted to travel and shoot in the heart of the Pamirs, while Sir Aurel Stein crossed the plateau from east to west, and penetrated to the amazingly interesting regions of Roshan and Darwaz.

The chief interest of this book lies in the fact that it recounts the impressions of a resident in a country which has so far been described only by the passer-by. Even a glimpse of life in the only city of Central Asia where the British Empire retains a representative should commend it to the reader. For years the post has been held by Sir George Macartney. Far removed from the nearest Englishman, cut off from India, isolated and alone, he has upheld the honour of the Empire, using prestige instead of Cossacks, and relying on his unrivalled knowledge of the East. Sir Percy Sykes had his work cut out to fill the gap satisfactorily, but his life experience in Asia served him well, and he has allowed us to see something of it.

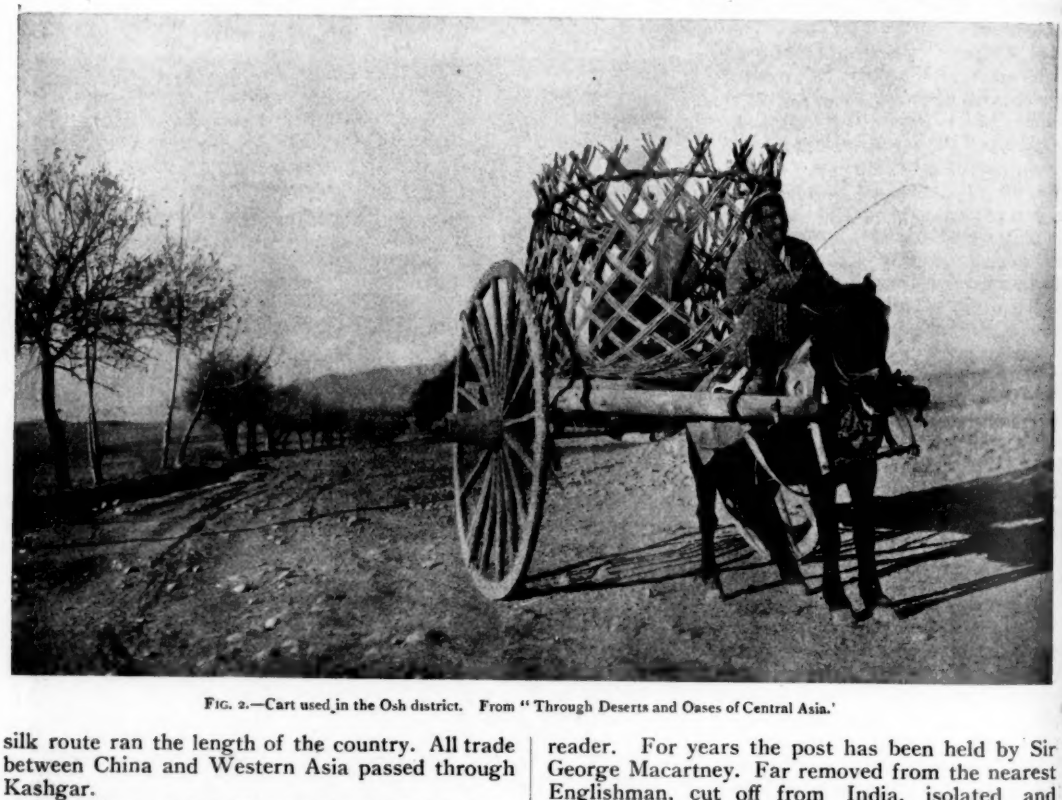


FIG. 2.—Cart used in the Osh district. From "Through Deserts and Oases of Central Asia."

The United States National Research Council.

By PROF. VERNON KELLOGG.

THE National Research Council is a co-operative organisation of men of science in America for the special purpose of promoting fundamental research in the physical and natural sciences, the application of scientific knowledge in the industries, and the training of research workers, all for the sake of the general advancement of science and the increase of the national strength and well-being. It was organised in 1916, under the auspices of the National Academy of Sciences, especially to help make the scientific resources of the country available to the Government in the solution of pressing war-time problems involving scientific investigation. As now reorganised on a permanent peace-time footing, its membership of about 250 is largely composed of duly appointed representatives of about forty major scientific and technical societies of America, with a group of administrative officers and necessary office staffs, resident in Washing-

ton. These officers are appointed for but one year at a time, and it is expected that most of the offices (chairmen of divisions, etc.) will be filled in rotation by men drawn from the scientific faculties of the universities, the staffs of large scientific institutes, and the research laboratories maintained by the industries.

Although during the war the Council was largely supported by the Government, it is now entirely supported by private funds. A gift of 5,000,000 dollars has recently been made to it by the Carnegie Corporation. Part of this money, perhaps a million dollars, will be used to erect a building in Washington for the offices, conference rooms, etc., of the Council and the National Academy of Sciences, and the remainder will constitute a permanent endowment for the Council. This endowment will provide for the administrative expenses of the organisation, leaving the funds necessary to aid in the support of the large co-operative scientific projects of research, which the Council hopes to stimulate or establish, to be found, as the needs require, from wealthy men or philanthropic foundations interested in the promotion of the investigation of the fundamentals of science and from the industries interested in promoting the extension of scientific applications.

The Council as at present organised includes thirteen divisions, seven representing the various major lines of science and technology, and six representing general relations. The first seven are divisions of the physical sciences, engineering, chemistry and chemical technology, geology and geography, the medical sciences, biology and agriculture, and anthropology and psychology. The general relations group includes a division of foreign relations, a Government division (including representatives of each of the major scientific bureaux included in the Government Departments of War, Navy, Commerce, Labour, Agriculture, State, and Treasury), a division of States relations, one of educational relations interested especially in the research conditions and activities in the colleges and universities of the country, a division of research extension especially devoted to the extension of research to the industries, and a research information service intended to act as a general national clearing-house for information concerning the scientific *personnel* and scattered research work of the country.

Affiliated with these various divisions are many special committees and sub-committees which concern themselves with various special phases and specific projects of scientific investigation. The present number of these committees approximates fifty. There is also a special Research Fellowship Board, which has at its disposal through the period from May 1, 1919, to June 30, 1925, the sum of 500,000 dollars, appropriated by the Rockefeller Foundation for the Maintenance of National Research Fellowships in Physics and Chemistry. Thirteen of these fellowships have so far been instituted.

The National Research Council is thus neither a great operating scientific laboratory nor an organisation possessing large funds from which to make direct gifts to individual scientific investigators or scientific laboratories, but an institution for the purposes of stimulating and organising scientific research in America, and of promoting international scientific relations in all possible ways. It is specially interested in organising scientific effort along co-ordinated co-operative lines. It hopes to encourage vigorous attack on major problems too large and many-sided for the individual investigator working alone, and often requiring the co-operation of numerous investigators and laboratories representing several different but allied lines of science. In the applications of science it is especially interested in such problems as bear directly on the promotion of the national strength and well-being.

Among the many projects now in course of organisation or actual development are an extensive study of food and nutrition in charge of a committee including many of the leading American physiological chemists and experts in human and animal nutrition; a study of high explosives, begun during the war; the preparation of critical compendia of physical and chemical constants; a study of the fundamental scientific problems of baking, of ceramics, of steel alloys, of synthetic drugs, of the chemistry of colloids, of sewage disposal, of forestry, of fertilisers, etc. An extensive investigation of tropical biology, including especially tropical medicine, is in course of organisation. A detailed survey of the research conditions in all the colleges and universities of the country, in which research work is now being done or probably can be done in the near future, is in active progress. A committee on mental measurements has recently completed an elaborate series of trials of group tests on several thousand children, and has prepared, and is about to publish, a set of recommended tests for use for classification and grading in the common schools of the country. These tests are adapted from the sets developed by the Council's special psychological committee on Army tests during the war. Altogether, the Council is getting under way a good deal of important research work, and promises to be an organisation of much influence in the promotion of American activity in the advancement of science.

Obituary.

MARLBOROUGH R. PRYOR.

SOME fifty years ago Marlborough Robert Pryor, who died at Weston Park, Stevenage, on April 3, was well known in scientific circles at Cambridge, and seemed likely to rise to a high position in those studies. He was a man of many interests and great adaptability of mind, who, though he was rather early diverted to executive business, never lost his interest in those parts of it which were connected with science. Educated

at Eton, he entered Trinity College, Cambridge, taking his degree as B.A. in 1870, and that of M.A. three years later. It is rather remarkable that he did not "go in for honours," for he was then so conspicuous a student of natural science as to obtain successively a scholarship and a fellowship by examination in those subjects, being in each case the first elected to these distinctions in Trinity College.

In Pryor's days natural science was beginning to look up in Cambridge, though it did not yet lead directly to a degree, for its first Tripos examination, when the list was headed by Prof. Liveing, was in 1858, four men being in the first class, and two in the second. Until 1869 the total number in all the classes rarely exceeded ten, and sometimes sank down to four, and on three occasions no one was in the first class. Things have changed since then, for in the days immediately before the war there would be some 120 or more in the three classes, as there doubtless will be again. But from 1870, when Pryor's name would have appeared had he gone in for the examination, the names of men who have since won distinction are more often found in the lists—such as H. Darwin (now Sir Horace); W. M. Hicks, of Sidney, who turned from science to theology and became Bishop of Bloemfontein; Garrod and Lydekker, Teall, Martin, Frank Balfour, M. Hartog, and Sollas, now professor of geology at Oxford, not to mention others.

Pryor, however, so far as I know, wrote no papers of importance on strictly scientific matters. I do not find his name in the earlier volumes of NATURE, which began to appear in November, 1869, nor is it in my catalogue of collected papers on scientific matters, which goes back to a still earlier date. Yet he won distinction at Cambridge, not only by his academic successes at Trinity, but also from all who met him there in scientific society. One could not be long with him without getting the impression that one was talking with a clear-headed man of strong intellect, who looked at things all round before he spoke of them, and expressed his views quietly and deliberately. He had a large store of knowledge and was a keen critic, yet never anything but kindly. He took a special interest in ornithology, and was a frequent member of that circle of young men of science which the late Prof. Alfred Newton delighted to gather round him on Sunday evenings after dinner in his rooms at Magdalene, where much tobacco was consumed and any amount of natural history was talked. These gatherings indirectly extended the interest felt in that subject in Cambridge, and perhaps were an even greater incentive to its study than any formal teaching by the professor.

Soon after taking his degree Pryor left Cambridge and entered on a business career in London, settling down near Stevenage, where he inherited from an uncle an estate called Weston Park. At first he joined a firm of South American merchants, and became a director of some important joint-stock companies. The two with which he was most closely and permanently connected—and they were businesses requiring especially a clear head and a sound judgment—were the Sun Insurance Office and the Sun Life Assurance Society, to each of which he became chairman, holding those offices until 1918. The prosperity of these institutions was the chief work of his later life, and he carefully studied the problems of insurance in all its branches. It is said that his views were strong and his business ideals high, and that nothing short of the strictest practice would ever satisfy him. But he was regarded with real affection by the other members of the boards, and to the younger of them his great store of knowledge on all sorts of subjects was a constant cause of wonder. Still, he kept up his connection with his college and his university, for he frequently came up to be present at special social gatherings in the former, and in later years took an active part in the endeavour to collect funds to advance teaching in the latter, which was gratefully acknowledged in a resolution passed the other day. Besides all this, he was a good Spanish scholar, and had paid much attention to church architecture, especially in Hertfordshire. He married Miss Alice Solly, of Serge Hill, in that county, and has left six daughters and one son, Col. Pryor, D.S.O., who served in France and Italy.

So, to the regret of many friends, Marlborough Pryor is gone. He has left no conspicuous record in the scientific annals of his generation, as once seemed probable, but no one can say that his life was wasted, because, while some men can serve science the better by taking a prominent lead in this or that branch of it, others can do it by the catholicity of their knowledge and interests. Marlborough Pryor was among the latter, and each has his work to do; each is helpful to his generation; for the one raises the towers; the other, as he did, builds the walls.

T. G. BONNEY.

MR. J. A. POTT, who died recently at the age of fifty-five, was a scholar whose importance as a moving force in his generation cannot be estimated by the popularity of his work during his lifetime. As an archæologist he contributed to the *Antiquary* for 1904 two articles on Neolithic and other remains found near Harlyn Bay, Cornwall. He made the first translation into English of two important treatises of Thomas à Kempis, entitled "The Founders of the New Devotion," and the "Chronicle of the Canons Regular of Mount St. Agnes." These were followed by two series of graceful renderings of poems from the Greek Anthology. Just before his premature death, due to overwork in recruiting during the war, he had completed a verse and prose translation of the Epigrams of Martial, which will shortly be published. A fine scholar and man of letters, Mr. Pott exercised an inspiring influence over a large group of friends drawn from circles largely differ-

ing both socially and intellectually. The charm of his personality depended on the fact that, happy as he was himself in living, he was still happier in making his life a blessing to others.

MR. A. H. HIORNS, who died on April 17, was for many years head of the metallurgical department of the Birmingham Municipal Technical School. He commenced teaching metallurgy about 1875 in branch evening classes under the auspices of the Birmingham and Midland Institute. Later he was transferred to the central school, and was so successful as a teacher that he was granted leave of absence in 1882 and 1883 to study at South Kensington under Sir W. Roberts-Austen. On his return to Birmingham he organised a new metallurgical department at the Birmingham and Midland Institute. As the work expanded, it was transferred to the Birmingham Municipal Technical School, where the enthusiasm and geniality of Mr. Hiorns gathered an ever-increasing number of students. Mr. Hiorns contributed papers on metallurgical subjects to various scientific societies, but was best known as the author of a number of students' text-books, which have had a wide circulation, and include "Practical Metallurgy and Assaying," "Metallography," "Metal Colouring," "Iron and Steel," "Mixed Metals," etc. He retired from teaching some eight years ago, and the latter part of his life was spent chiefly in rural pursuits.

T. T.

MR. T. W. BACKHOUSE, of West Hendon House Observatory, Sunderland, who died on March 13 in his seventy-eighth year, devoted a large part of his life to scientific pursuits, and carried on for more than sixty years a series of meteorological and astronomical observations. He was a frequent contributor to our correspondence columns, and a most successful student of those minute differences in the appearance of the sky or of the atmosphere that escape untrained observers, who prefer to consult the barometer rather than natural phenomena. Four volumes of Publications were issued by him from his observatory, and the last, in 1915, summed up the accumulated records, extending over fifty years, of his skill and vigilance as an observer. In 1912 Mr. Backhouse published a valuable new catalogue of 9842 stars, containing all stars conspicuous to the naked eye. The catalogue was designed specially to afford assistance in the observation of meteors, to which Mr. Backhouse himself gave much attention; but it has been found useful by many other astronomers. His last communication was on the subject of the January meteors (Quadrantids) of 1917 (NATURE, vol. c., p. 313). Mr. Backhouse became a fellow of the Royal Astronomical Society in 1873, and of the Royal Meteorological Society in 1892.

Notes.

THE PRINCE OF WALES having graciously consented to be nominated as an honorary fellow of the Royal Society of Edinburgh, the nomination was made at the last ordinary meeting on May 3, and the election will be carried out, according to regulation, at the ordinary meeting to be held on June 7.

THE Croonian lecture of the Royal Society will be delivered by Prof. W. Bateson on June 17 upon the subject of "Genetic Segregation."

MR. J. H. LESTER has been elected chairman of the chemical section of the Manchester Literary and Philosophical Society for the session 1920–21.

NOTICE is given by the Chemical Society that applications for grants from the society's research fund must be made, on forms supplied, to the assistant secretary, Chemical Society, Burlington House, W.1, on or before June 1.

MR. WILFRED H. PARKER has been appointed director of the National Institute of Agricultural Botany. The institute, including the Official Seed-testing Station for England and Wales (the director of which is Mr. Saunders), will be housed at Cambridge in a large building which will be completed by next summer. Meanwhile the temporary office of the institute is at 72 Victoria Street, London, S.W.1.

THE Salters' Institute of Industrial Chemistry invites applications for fellowships of the annual value of 250*l.* from those who in October next will have completed three years' training in chemistry and desire ultimately to enter upon an industrial career. The applications, including particulars of the candidates' training and war service, must be sent to the director of the institute, Salters' Hall, St. Swithin's Lane, E.C.4, by, at latest, July 1.

A REPORT by Dr. A. Mearns Fraser, Medical Officer of Health for Portsmouth, upon the prevention of venereal diseases was noticed in NATURE of March 25 (p. 114). The Society for the Prevention of Venereal Disease now informs us that the Portsmouth Borough Council has decided that steps shall be taken to educate the male inhabitants of the borough in the facts put forward by Dr. Fraser as to methods of prevention by immediate self-disinfection.

SCIENTIFIC visitors to the Royal Academy's exhibition this year will be much interested in the fine presentation portrait of Sir Clifford Allbutt painted by Sir William Orpen. The picture hangs in the first gallery and bears the inscription: "Sir Clifford Allbutt, K.C.B., M.D., F.R.S., Regius Professor of Physic in the University of Cambridge; President of the British Medical Association. Presented to him by his Profession, 1920." A proof of the mezzotint engraving of the portrait is exhibited in the room devoted to engravings, drawings, and etchings.

THE Department of Scientific and Industrial Research announces that the third Conference of Research Organisations will be held to-morrow,

May 14, at 3 p.m. in the lecture theatre of the Institution of Civil Engineers, Great George Street, Westminster. An introductory address will be given by the Marquess of Crewe, who will be chairman of the conference, and it will be followed by papers on "The Relation of Research Associations to Existing Institutions for Research," by Dr. A. W. Crossley, and on "The Staffing of Research Associations: Salaries and Superannuation," by Mr. J. W. Williamson.

IN an article in the *Times* for May 3 Mrs. Ayrton presents what must appear to be a formidable indictment of the War Office for neglect in regard to the use of the anti-gas fan. It is stated not only that there was great difficulty in getting the device considered, but also that, after its efficacy had been demonstrated, its adoption was delayed. Further, it is alleged that the supply of fans was never adequate, that the method of using them was never properly taught, and that to the last less efficacious measures were adopted in preference to the fan. It is suggested that this neglect on the part of the War Office entailed death to numbers and untold suffering to countless others. Many charges of grave neglect have been levelled against the War Office. The present one, however, is peculiar in being a charge, not against the military element, but rather against the experts who were associated with the Gas Service. It is well known that the Anti-Gas Service of the Army was, in the field, in the research laboratory, and on the instructional side, in most of the chief appointments, staffed by well-accredited men of science, and that both at the central laboratory in France and in London competent men were keenly on the alert to test and improve defensive measures. In view of this, it appears scarcely likely that Mrs. Ayrton's allegations will be accepted without question, and it is much to be desired that some plain statement of the facts should come from the men of science whose intelligence and humanity are implicity assailed in her article.

ON the occasion of a luncheon given by the *Times* last week to celebrate the first attempt to fly from Cairo to the Cape, Dr. P. Chalmers Mitchell, who accompanied Capts. S. Cockerell and F. C. Broome as scientific observer, made some interesting remarks on the value of aviation in scientific exploration. The aviator has an opportunity denied to the explorer on land of seeing the general lie of the country and the broad features of its topography. The view of a large tract of country makes it possible to appreciate and explain features which would be puzzling when seen piecemeal or partially by the surface traveller. This applies particularly in a country such as Africa, where much detailed exploration has been done in places before the broader features are understood. Dr. Chalmers Mitchell believes that geographical and geological exploration will benefit widely by the use of aeroplanes. Another interesting point he emphasised was the unexpected number of natural aerodromes which the flight revealed. Several times when the machine was forced to make unexpected descents, suitable places were found. Dr. Chalmers Mitchell pointed out that a re-survey of the Cairo-Cape route from the air made in order to locate these natural aerodromes would save the cost of many intermediate stations that are being planned.

THE trustees of the British Museum have arranged to purchase the whole of the collection of Lower Palæozoic fossils made in the Girvan district by Mrs. Robert Gray, of Edinburgh. The number of specimens is more than 38,000. Fossils from these rocks are scarcely represented at all in the British Museum, and very meagrely even in the Scottish museums. Apart from the specimens collected some fifty years ago by Mr. Robert Gray and now in the Hunterian Museum, Glasgow, there is little worth considering outside the present Gray collection. Mrs. Gray has diligently continued the work begun by her late husband, so that the whole series is admirably represented in her collection. She has also taken pains to get her material described, and it forms the foundation of a long series of memoirs. Noteworthy among these are the well-known work by Nicholson and Etheridge on "The Silurian Fossils of the Girvan District" (1878–80), the Palæontographical Society's monographs by Cowper Reed, W. K. Spencer, and Ida Slater, and the large memoirs in the Transactions of the Royal Society of Edinburgh by Reed and by Bather. In spite of these publications, the collection is known to contain undescribed material scarcely less in extent and importance. The situation of the rocks near the northern limit of the Ordovician and Silurian sea, and the richness of certain beds of a facies different from their representatives elsewhere, have led to the inclusion of a number of rare forms in the fauna. Among these are a new and strange cystid, Cothurnocystis; starfishes carrying back to the Ordovician plans of structure previously regarded as Devonian; echinoids among the oldest known and of a type hitherto unrecognised before the Upper Silurian; a remarkable edrioasteroid, Pyrgocystis; beautiful examples of the supposed cirripede, Turrilepas; and two new species of the very rare Helminthochiton.

THE thirty-first annual Conference of the Museums Association will be held in Winchester on July 5–8, under the presidency of Sir Martin Conway, Director-General of the Imperial War Museum. The meeting this year is a joint conference with the French Museums Association, and among those who have signified their intention of attending are M. Hughes Leroux (senator), M. le Prof. Louis Roule (Paris Museum), M. le Prof. Vayssière (president of the French Museums Association), M. Fernand Guey (treasurer of the French Museums Association and director of the Museum of Fine Arts at Quimper), Dr. A. Loir (secretary of the French Museums Association), and a delegate from the French Association for the Advancement of Science. The mornings during the conference will be devoted to the reading and discussion of papers, and the afternoons to visits to places of special interest to museum workers. The subjects for discussion at the conference are: (1) The Public Libraries Act of 1919, and its effect on the future policy of museums; (2) the status and remuneration of museum curators and their staffs; and

(3) the desirability of a diploma for museum curators and the necessary course of training. In addition, the following papers have been promised: (1) "The Lighting of Picture Galleries and Museums," by Mr. Hurst Seager, vice-president of the New Zealand Institute of Architects; (2) "The Selection of Pictures for Municipal Art Galleries," by Mr. E. Howarth, curator of Sheffield Public Museums; and (3) "A Central Government Department for Museums and Art Galleries," by Dr. F. A. Bather. Mr. R. W. Hooley, Earlescroft, St. Giles's Hill, Winchester, has undertaken the duties of local secretary, and a small committee under the chairmanship of the Rev. S. A. McDowall, Winchester College, has been formed to arrange the programme of local visits.

THE next informal meeting of the Chemical Society will be held at Burlington House on Thursday, May 20, after the conclusion of the formal business of the ordinary scientific meeting. An exhibit demonstrating the methods of controlling soil organisms now being investigated at the Rothamsted Experimental Station will be shown by Mr. and Mrs. D. J. Matthews. This exhibit will include specimens of the soil organisms and the cultivation of these on artificial media. The effect of toxic substances on organisms and of the relationship of chemical composition to toxicity, with specimens illustrating effective doses of certain typical substances with a given quantity of soil, will also be shown. Dr. Marie Stopes will exhibit specimens and microscopic slides of fusain, durain, clarain, and vitrain, the four main constituents of banded bituminous coal. Mr. E. R. Thomas will show some experiments illustrating the influence of temperature, concentration, solvent, constitution, and catalyst on the rate of chemical change.

A SHORT article in our issue of March 11, p. 56, describing a magnetic disturbance which occurred on March 4–5, mentioned that aurora had been observed at Aberdeen on March 4, but considerably earlier than the commencement of the disturbance, and so presumably not directly connected with it. This seems to have been the only observation of aurora in this country on either March 4 or 5. A letter, however, which we have received from Prof. A. S. Eve, of Montreal, mentions a brilliant aurora as having been observed there between 1 a.m. and 2 a.m. G.M.T. on March 5, and so synchronous with the magnetic storm. Commencing with isolated patches, the aurora appeared for a short time in the form of an arc, and ended in a curtain display. This incident leads Prof. Eve to inquire whether there is in existence "an organisation for recording, with accurate timing, auroræ in both northern and southern hemispheres, and, if so, where can the records be obtained?" So far as we are aware, no such records exist. The question seems to merit the consideration of the recently instituted Section of Terrestrial Magnetism and Electricity of the International Geodetic and Geophysical Union.

THE Marlborough College Natural History Society, which has been in existence for fifty-six years, is a notable example of the good work which an association of schoolboys can perform under competent guidance. The report of the society for 1919 announces the retirement from the post of president of Mr. J. C. Alsop, who carried on the work with success during the period of the war. In botany 205 species, in ornithology 85, and in entomology 223 have been recorded. Lichenology shows a good record, though the subject has been little worked in this country, but the monograph on British species recently published by the British Museum and edited by Miss A. L. Smith may stimulate interest. A good course of lectures delivered by eminent specialists and numerous papers read by members during the year form an interesting feature of the report, which is carefully prepared, and furnishes a good example for the authorities of other schools in Great Britain.

DR. CHARLES SINGER has reprinted an address delivered before the British Academy (Proceedings, vol. ix.) on "Early English Magic and Medicine." The history of medicine is sharply divided into the Dark Age period and that which followed the arrival of the Arabian learning, the remnant of Greek science which survived in the Moslem world. Dr. Singer deals only with the pre-Arabian material. In England the latter has survived from two channels, manuscripts and folk-lore. Greek medicine reached the barbarian peoples of the West at a time when the scientific system of Greece was in complete decay, and it came through Latin channels. In dealing with magic Dr. Singer remarks that ecclesiastical elements are found throughout the whole corpus of Anglo-Saxon medicine and magic. Native Teutonic magic and medicine may be distinguished from imported elements of classical, ecclesiastical, or Salernitan origin by the presence of four characteristic elements: the doctrine of specific venoms, the doctrine of the Nines, the doctrine of the worm as a cause of disease, and, lastly, the doctrine of the elf-shot—all of which are fully described. "The Celtic influence in the Anglo-Saxon material is elusive and yet pervasive, but the difficulty of tracing it may be a result of the common heritage of the two cultures and the common external influences to which they were both subjected."

MESSRS. SUTTON AND SONS, Reading, have published an interesting contribution to the literature on seed electrification. This bulletin (No. 11) presents the results of a number of germination and field tests carried out in 1919 with seeds of carrot, swede, cabbage, and mangold. The best-known process of seed electrification, viz. the Wolfryn process, consists in immersing the seeds in a solution either of common salt and water or of calcium chloride and water, through which an electric current is then passed. After this treatment the seeds are dried at a temperature of 100° F., and they are then ready for sowing. Obviously two processes are here involved, seed immersion and seed electrification, and the Reading experiments were designed primarily to test the value of the Wolfryn process, and secondarily, if there are advantages, to decide whether they are due to the immersion, to the electrification, or to both agents combined. Tests were made with untreated seeds, with seeds electrified by the Wolfryn process, with seeds soaked in a solution of sulphate of am-

monia, and with seeds soaked in a solution of salt and water, the strength of the solution being the same as that used in the Wolfryn process. After immersion the seeds were dried at 100° F. and then sown. Regarding the tests as a whole, they do not reveal any advantage from seed electrification, the only possible exception occurring in the case of mangolds, where the germination of the electrified seed was 94 per cent., compared with 82 per cent. for the untreated seed and 86 per cent. for the seed soaked in the salt solution, while in the field tests the electrified mangold seed yielded 62 lb. per pole more than the untreated seed. In all other cases either the electrified seed gave a lower yield than the seeds treated in other ways, or the increase following electrification was so small as to be negligible.

THE Government of India is now considering the principles under which the census of 1921 is to be undertaken synchronously with those of the nations of civilised Europe. Hitherto the reports have included much valuable anthropological material, but this is found to be in practice of little value to the bureaucracy. The time, it is said, has come for a scientific demographic census, one which collects such statistical details as will throw light on all the problems of population, such as the causes which increase or decrease peoples or sections of peoples in numbers, by sexes, in efficiency and capacity for progress. More, we want to know the real causes why the Moslem population increases at a faster rate than the Hindu, and the causes of the excess of male births, of the variability of sex mortality, and of polygyny and polyandry. To carry out such a scheme it will be necessary to work in close collaboration with European experts. In former census reports the mass of anthropological material made them a happy hunting-ground for European workers. If future reports are to be confined to inquiries of a sociological kind, we trust that efforts will at once be made to continue the ethnological survey on wider lines. The scheme initiated by Lord Curzon has led to little result; and while Madras, the Central Provinces, Burma, and the Punjab have issued some important publications, practically nothing seems to have been done after twenty years' incubation in Bombay, Bengal, and the United Provinces.

THE *Meteorological Magazine* for April contains an article on "Climates of the British Empire Suitable for the Cultivation of Cotton," by Mr. C. E. P. Brooks. Details with respect to rainfall and temperature of a cotton-growing climate are given for various British Possessions and Colonies. It is stated that the essential features are: (1) The mean annual temperature should not be below 60° F. (2) The mean temperature of the warmest month should exceed 80° F., or the mean of the three warmest months should exceed 77° F. to get the best results; this condition, however, is not so important as the first. (3) The interval between killing frosts (or droughts) should be at least 200 days. (4) The annual rainfall should not exceed about 60 in. for good crops, though cotton of a poorer quality can be grown in much wetter climates; unless irrigation is possible, the annual fall should not be less than 23 in. (5) There must be plenty of bright sunshine. A dull and humid atmosphere is particularly unfavourable to the cotton plant.

MR. G. W. LAMPLUGH'S address as president of the Geological Society of London appears in the Quarterly Journal of that Society, vol. lxxv., part 1, published in January, 1920. Its theme is that studies of the thicknesses of English sedimentary series show that an anticlinal uplift is the sequel to deposition in a gradually deepening trough. Hence the greatest thicknesses of strata are now found near the escarpments, from which the beds thin away towards the margins of the former trough. The Weald, the Jurassic uplands, the Trias, and most of our Carboniferous rocks are cited as examples. The Jurassic beds beneath the Weald still retain the synclinal structure; but the "partial recovery" of the trough is marked as we pass upwards through the Wealden series to the Chalk. The sections given provide much material for thought.

THE latest addition to the series of Special Reports on the Mineral Resources of Great Britain, issued by the Geological Survey, is vol. xv. on "Arsenic and Antimony Ores," by Henry Dewey. As neither of these substances is produced in any very important quantities in this country, the report is necessarily a brief one, though the subjects are treated quite thoroughly. In the case of each metal there is given a general account of the mode of occurrence and of the distribution of its ores, followed by a detailed description of all the mines that have produced any noteworthy quantity. There is practically no antimony at all produced in Great Britain, but Cornwall and Devon still rank as relatively important contributors to the world's output of arsenic, much of this being obtained as a by-product from Cornish tin-mines. As has been pointed out by Sir Aubrey Strahan, the main value of this report lies in the fact that it has brought together in a convenient and readily accessible form a quantity of information previously scattered through a number of publications, which is thus rendered readily available to those interested in the various industries which make use of the metals here discussed or of their compounds.

THE April issue of the Journal of the Institution of Electrical Engineers contains the paper read by Mr. R. S. Whipple at the joint meeting of the institution and the electro-therapeutics section of the Royal Society of Medicine on electrical methods of measuring body temperatures. After describing the modern resistance thermometer and the thermo-electric couple methods of measuring temperature, he comes to the conclusion that for ordinary work records of body temperature and its variation can best be obtained by means of a resistance thermometer placed in the rectum. For more accurate work a thermo-electric couple with a photographic recorder must be used, especially if rapid or minute variations of temperature are to be detected. The resistance thermometer may be made of platinum wire of about 1/20 mm. diameter, have a resistance of about 140 ohms, and be used with a moving-coil galvanometer in a resistance

bridge with arms of about the same resistance. A suitable thermo-electric couple is provided by copper and constantan, an alloy of about 60 per cent. copper and 40 per cent. nickel. A moving-coil galvanometer of coil resistance 10 ohms or less is suitable, with a balancing resistance placed in series to give a convenient scale deflection.

IT is a sign of the spirit which we have so long worked to encourage, to find on opening last month's issue of *Beama*, the excellently produced journal of the British Electrical and Allied Manufacturers' Association, an article by Mr. E. B. Wedmore urging the importance of co-operative scientific research. Mr. Wedmore points out how the war has taught us the value of concerted action, and shows that combined rather than individual research facilities are particularly necessary in view of the present shortage of scientifically trained technical men. Among articles which follow, indicating some of the enormous industrial structures already raised on foundations of scientific endeavour, is one by Mr. W. E. Hughes sketching the many uses to which the electro-deposition of metals has been put. An interesting example is the building up of worn engine parts, such as crankshafts, by deposits of iron—a practice developed by the Royal Air Force in face of some difficulty during the war. The author, however, points out how the serious lack of educational facilities has hampered British progress in these branches of electro-metallurgy. Another interesting article by Mr. A. B. Searle deals with the preparation of tungsten and its important uses in the filaments of modern incandescent lamps and of the three-electrode ionic valves upon which many of the recent developments in wireless telegraphy are based. Notwithstanding the large amount of research that has led up to the present processes, the author characterises them as "making the best of a bad job." If means could be found for melting the purified tungsten economically, the quality of the filaments would be greatly improved. Unfortunately, however, this cannot be done at present, he concludes, owing to the extraordinarily high melting point of the metal (more than 3000° C.) and the difficulty of heating it to this temperature out of contact with carbon.

THAT "small things often very considerably affect the destinies of great ones" is the appropriate motto chosen to introduce a paper on lubricants read by Mr. G. F. Robertshaw at a meeting of the Institution of Petroleum Technologists on April 19. One object of the paper was to urge a plea for uniformity in the methods of examining lubricating oils. At present there is a diversity of practice which is liable to produce confusion and uncertainty in judging lubricants from the physical and chemical data obtained in testing them. For instance, there are half a dozen kinds of instruments used for determining the viscosity of oils, and the results are expressed in different terms, depending upon the particular viscometer employed. Hence an appeal is made that the absolute viscosity, or some convenient multiple or sub-multiple of it, should uniformly be used as the standard method of expression. The paper also, it may be noted, affords a convenient reference to the somewhat extensive literature upon lubrication. Without compiling a complete bibliography, the author directs attention to many useful sources of information, historical, scientific, and practical. On the question of "oiliness"—a property possessed by good lubricants which at present cannot be specified in definite terms—it is remarked that this property is not necessarily proportional to viscosity. Whilst the late Sir Boverton Redwood's dictum is still true, that viscosity is our most valuable test of lubricating quality, there yet remains the fact that for the same viscosity the fixed vegetable and animal oils have usually a greater "oiliness" than mineral oils.

A NEW view of the nascent state is put forward by C. Zenghelis in the *Comptes rendus* of the Paris Academy of Sciences for April 12. Experiments are described which show that the chemical activity of such gases as hydrogen, oxygen, nitrogen, or carbon monoxide is increased by bringing them in contact with solutions in very minute bubbles. This fine state of division is obtained by forcing the gas through cartridges of paper, the pressure inside the cartridge being so adjusted that the gas does not bubble through, but reacts with the dissolved body in the pores of the paper. Before each experiment a blank was made with each cartridge alone to prove that the paper had no action on the solution. Under these conditions hydrogen was proved to reduce mercuric chloride to calomel, potassium nitrate to nitrite, carbon dioxide to formaldehyde, and substances giving a sugar reaction. With oxygen gas ammonia was oxidised to nitrous acid, and methyl alcohol to formaldehyde. With nitrogen and hydrogen sufficient ammonia was produced in half an hour to give a reaction with Nessler solution. Carbon monoxide reduced iodic acid and sodium molybdate. All these reactions took place at ordinary temperatures. Fuller details of the experiments will be published later.

PROF. A. N. WHITEHEAD is publishing almost immediately through the Cambridge University Press the Tarner lectures delivered by him in November last. The volume will be entitled "The Concept of Nature," and form a companion to the same author's "Enquiry Concerning the Principles of Natural Knowledge." It will, however, be less mathematical than the earlier work.

THE Cambridge University Press announces the publication in June of "The Influence of Man on Animal Life in Scotland: A Study in Faunal Evolution," by J. Ritchie. As the title implies, the book will deal with the bearing of man upon the character and composition of the fauna of Scotland. It will be fully illustrated and contain eight maps.

THE latest catalogue (No. 401) of Mr. Francis Edwards, 83 High Street, Marylebone, W.1, gives particulars of 757 books on the Far East—China, Japan, and the Malay Archipelago; also of the Far North-East of Asia, including Siberia and Kamtchatka. Many of the works are scarce, but the majority are listed at greatly reduced prices. The catalogue will be sent free upon request.

Our Astronomical Column.

CONJUNCTION OF MARS WITH SPICA.—Interesting, though not extremely close, approaches of Mars to the bright star Spica Virginis will occur on May 22, when Mars will be situated 2½ degrees north of the star. On that night the planet will pass the meridian at 9.21 G.M.T. at an altitude of about 30 degrees. On succeeding nights Mars will be observed to the N.N.W. of the star, but on June 2 will become stationary, and thereafter move slowly eastwards. On June 12 he will again be in conjunction with Spica Virginis, and about 1°37′ N. of the star. Mars will cross the S. meridian 10 minutes before sunset on the latter night, and a good view will not be obtainable of the planet and star until 9 p.m. G.M.T. and afterwards. Mars will be much the brighter of the pair, and visible at an earlier time than the star. The two conjunctions will form attractive and striking configurations.

THE DUPLICITY OF ν GEMINORUM.—There is an article on this star by Dr. Bernewitz in *Astr. Nach.*, 5041. The orbit as a spectroscopic binary was investigated in the Publications of Ottawa Observatory (vol. iv., No. 19). The period is 9·6 years, and the value of $a \sin i$ is 1,400,000,000 km. This large value suggested that it might not be impossible to detect the duplicity visually. It has been examined with the 65-cm. refractor at Berlin-Babelsberg Observatory by Dr. Bernewitz, Dr. Bottlinger, Prof. Guthnick, and Mr. F. Pavel. All agree that the image is distinctly elongated. Neighbouring stars of similar magnitude appeared perfectly round, so that it is concluded that the effect is not instrumental. On examining ν Geminorum through increasing thicknesses of a dark wedge it was found that before it disappeared it became round; they conclude from this that the companion is about 1 magnitude fainter than the primary. This difference removes uncertainty as to the quadrant. Dr. Bernewitz and Mr. Pavel each measured the pair on five nights, and their respective results are:

Date	P.A.	Distance.
	°	″
1920·208	116·2	0·14
1920·205	124·3	0·16

They state that the spectroscopic results indicate that the star is now near elongation. If measures can be obtained over a sufficient arc of the orbit, it will be possible to deduce the parallax and mass. The spectral type is B5, so that a mass-determination would be of particular interest.

KODAIKANAL OBSERVATIONS OF PROMINENCES.—Vol. i., part 2, of the Memoirs of Kodaikanal Observatory has lately been distributed. It contains a full description, with numerous photographs, of the prominence observations made by Mr. and Mrs. Evershed, and a discussion of their distribution and motion. Their preponderance at the sun's eastern limb, which many observers have noticed, is difficult to explain except as an earth effect. It will be remembered that Mr. Evershed has recently noticed another sign of an earth effect in the distribution of line-of-sight velocities in the photosphere.

It is pointed out that besides the principal prominence zones, which coincide with those of sunspots, there are also high-latitude zones. The prominences in these are less active than the equatorial ones; they frequently appear as pyramids, or rows of round patches. Their wave of activity begins in latitude 50°, soon after sunspot maximum; it travels poleward, reaching the pole about the next maximum and dying out there. It is suggested that the change in the corona round the poles, which takes place in the sunspot cycle, may be connected with this prominence fluctuation.

The rotation of the prominences has been studied at Kodaikanal; it is found to be more rapid than that of the photosphere. Line-of-sight velocities and disc observations of long-lived prominences agree in supporting this. It is concluded that the prominences are so tenuous that the free path of the atoms is infinite. Their luminosity "is due to the internal energy of the atoms, perhaps derived mainly from absorption of the intense solar radiation."

Leonardo da Vinci.[1]

By EDWARD MCCURDY.

WITH the list of war inventions may be numbered Leonardo's researches in aviation. He pursued this subject for many years. His studies range from the consideration of the primary causes of flight in birds and other winged creatures to the invention of a screw propeller and the consideration of its applicability to aerial navigation. He also made an actual attempt. Jerome Cardan, the physician who made a horoscope for Edward VI., in his work "De Subtilitate" refers to an unsuccessful attempt at flight made by Leonardo da Vinci, and adds somewhat dryly, "He was a great painter." A sentence on the cover of Leonardo's manuscript, "Sul Volo degli Uccelli," written in 1505, has been interpreted as referring to this attempt. "The great bird," it runs, "will take its first flight upon the back of the great swan, filling the whole world with amazement, and filling all records with its fame; and it will bring eternal glory to the nest where it was born."

This enigmatic utterance may be somewhat more comprehensible if it is remembered that *cecero* is the Italian word for swan, and "the back of the great swan" may therefore be interpreted as a reference to Monte Ceceri, a hill to the south-west of Fiesole, from which it is believed the flight took place.

From the meagre records of the attempt we pass to researches in theory and construction.

The material falls naturally into two groups, the first being a series of investigations of the laws which govern the power of flight as manifested in Nature by birds and other winged creatures, the second consisting of deductions from these principles in the construction of a mechanism which should be capable of sustaining and being worked by man. The interdependence of the two parts of the inquiry is stated with great succinctness in a passage in the Codice Atlantico:

"A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements, but not with a corresponding degree of strength, though it is deficient only in the power of maintaining equilibrium. We may therefore say that such an instrument constructed by man is lacking in nothing except the life of the bird, and this life must needs be supplied from that of man.

"The life which resides in the bird's members will, without doubt, better conform to their needs than will that of man, which is separated from them, and especially in the almost imperceptible movements which preserve equilibrium.

"But since we see that the bird is equipped for many obvious varieties of movements, we are able from this experience to deduce that the most rudimentary of these movements will be capable of being comprehended by man's understanding: and that he will to a great extent be able to provide against the

[1] From a discourse delivered at the Royal Institution on Friday, March 19. Continued from p. 309.

destruction of that instrument of which he has himself become the living principle and the propeller."

In the analogy thus drawn from Nature to the problem before him, Leonardo has anticipated the attitude of modern research.

In his construction of the instrument he finally attempted to combine the type of the lark soaring with its wings open with that of the bat as it descends. He does this by the introduction of *sportelli* (trap-doors or shutters) in the surface of the wings, whereby, as he says, "the wing is full of holes as it rises and closes up when it falls." The shutters should have rims of cane and be covered with starched taffeta to render them airtight. Perhaps it was after the Monte Ceceri attempt that he wrote on a page of MS. B of the Paris manuscripts, "Try the actual instrument in the water, so that if you fall you will not do yourself any harm." It may also have been the failure of this attempt that caused him to search for a fresh source of motive power to take the place of that exerted by the muscles of a man. On 83 verso, MS. B of the Paris manuscripts, there is a drawing of a large screw constructed to revolve round a vertical axis, and a note explains its intended use: "If this instrument made with a screw is well made—that is to say, made of linen of which the pores are stopped up with starch—and is turned swiftly, the said screw will make its spiral in the air, and it will rise high."

Leonardo adds that a small model may be made of cardboard, with the axis formed of fine steel wire bent by force, and that this when released will turn the screw. To his drawing of this instrument the architect Luca Beltrami has—to me, as it seems, justly—applied the word "aeroplane."

Another page in the Codice Atlantico (311 v. d.) of unique interest contains three studies of artificial wings, a name, and a note that the machine is to be made, not with *sportelli*—that is, shutters—but united. The natural interpretation is that the note refers to a commission for the construction of a machine for flight, with regard to which the patron, Gian Antonio de Mariolo, has expressed a desire that the wings should be such that no wind would be able to pass through them as it would if they had shutters, *i.e.* should be like the wings of the bat.

Leonardo's researches in natural and applied science cover so wide a field, and specialisation in these days has so divided knowledge into watertight compartments, that properly to gauge the value of his contributions to scientific research would require a combination of many trained intelligences. But it is not possible to devote a number of years to the close study of all that concerns Leonardo without becoming imbued with the conviction of the complete oneness of his work and method. The dominant purpose which animates him, whatever the nature of the problem, is to investigate, to examine, and to define primary causes. His pen reinforces his practice. "Nature," he says, "is constrained by the order of her own law, which lives and works within her." Again, "There is no result in Nature without a cause; understand the cause, and you will have no need of the experiment"; and "Nature is full of infinite causes which were never set forth in experience."

With Leonardo the latter end of this search forgot the beginning. His intellectual curiosity into the origins and causes of all created things is revealed in infinite variety in the thousands of pages of his manuscripts, compact, as has been said, "of observation, of prophecy, of achievement," and in his triple legacy forming a record probably unequalled, certainly unsurpassed, by that of any other man in the history of the world. For consider what he was! Painter, sculptor, engineer, architect—all these to the wonder of his contemporaries. His manuscripts reveal that he was no less distinguished as physicist, biologist, and philosopher. But in the field of science he was essentially a forerunner. The results that he achieved must be reckoned as small compared with his grasp of basic principles, with the vistas that he opened up, and with the unerring instinct which he displayed in choosing the true method of investigation.

All Leonardo's writings connected with science seem, as it were, fragments of a larger purpose, charted, defined, explored, but never fulfilled, of which his researches in anatomy, zoology, physiology, embryology, and biology are the allied and component parts. Discerning the essential unity of man and the animals —"because," as he says, "all land animals have similar members—that is to say, muscles, nerves, and bones—and these members do not vary at all except in length and thickness" (MS. G, 5 verso)—he may be said to have founded comparative anatomy. Drawings now at Windsor show the gradations of the human type merging into that of various animals. Leonardo tracks the mystery of life from the conception and the fœtus through growth to maturity, and so to the gradual wasting of the tendons and all the physical phenomena of death.

"I have dissected," he says, "more than ten human bodies, destroying all the various members, and removing even the very smallest particles of the flesh which surrounded these veins without causing any effusion of blood other than the imperceptible bleeding of the capillary veins. And, as one single body did not suffice for so long a time, it was necessary to proceed by stages with so many bodies as would render my knowledge complete; and this I repeated twice over in order to discover the differences."

The drawings made in the course of these investigations, now in the Royal Collection at Windsor, were examined in the time of George III. by the famous surgeon William Hunter, who, approaching them with natural professional distrust, thus made the *amende honorable*:—

"I expected," he says, "to see little more than such designs in anatomy as might be useful to a painter in his own profession. But I saw, and indeed with astonishment, that Leonardo had been a general and deep student. When I consider what pains he has taken upon every part of the body, the superiority of his universal genius, his particular excellence in mechanics and hydraulics, and the attention with which such a man would examine and see objects which he has to draw, I am fully persuaded that Leonardo was the best anatomist at that time in the world." Although he does not fully explain its mechanism, he evidently knew of the circulation of the blood a hundred years before Harvey gave the knowledge to the world. "The heart," he wrote, "is a muscle of great strength; the blood which returns when the heart opens again is not the same as that which closes the valve."

The depth and variety of his researches in other branches of natural science may be inferred from the citation of a few instances in which he anticipated the results of investigations associated with other names. Either before, or at latest during such time as Copernicus was laying the foundations of his heliocentric theory by study at Bologna and Padua—a theory afterwards brought to completion and published in his work, "De Revolutionibus Orbium Cœlestium," in 1543—Leonardo had enunciated the ruling principle of it in a line in the manuscripts now at Windsor, "Il sole non si muove" ("The sun does not move").

A hundred years before Maestlin, who is credited with the discovery, he had defined the obscure light of

the unilluminated part of the moon as due to reflection from the earth's surface.

In the search for hidden laws and causes the scientific problem followed hard upon the artistic problem. The study of perspective led to that of light and shade, and so of optics—the study of the structure and functions of the eye, as being the instrument by which light and shade are perceived. He made a model of its parts, and showed how an image is formed on the retina, thus refuting the currently accepted belief of the eye throwing out rays which touch the object it desires to examine. He described also the principle of the *camera obscura* ninety years before Porta developed the idea in practice.

In mechanics he enunciated the theory of inertia, afterwards demonstrated by Galileo, and relegated the theory of perpetual motion then current to the same category as astrology and necromancy. He refound the wisdom of Archimedes, and demonstrated his theory of oblique forces applied to the arm of the lever, afterwards associated with the name of Galileo. Following on Archimedes's conception of the pressure of fluids, he showed—a century and a half before Pascal—that liquids stand at the same level in communicating vessels, while if the two arms are filled by different liquids the heights will vary inversely as their densities.

Leonardo is at once artist and man of science in his treatment of, and interest in, water. He studies its properties and power of movement under conditions varying from the action of the tides of the ocean to the laws which regulate the movement of water in siphons—a subject on which he notes his intention of writing a treatise. He follows its transformation into vapour, rain, dew, snow, and ice. It winds mysteriously in wonder-working coils through the landscape backgrounds of his pictures. He traces the infinite shapes it assumes, falling in violence of movement in spirals and eddies, circling like the loop of a swallow's flight, something of the artist's sheer delight in the creation of beauty of form mingling with the purpose of the man of science to wrest from this variety its underlying principle. Or again, as engineer he harnesses its power, studying to divert its channels either in menace of war or for purposes of commerce or irrigation.

In considering a geological problem his method is entirely deductive. "Since," as he says, "things are far more ancient than letters," he turns from authority to the testimony of things themselves. "Why," he asks, "do we find the bones of great fishes and oysters and corals and various other shells and sea-shells on the high summits of mountains by the sea just as we find them in low seas?" The fact that the cockles were living at the time when they became embedded in the strata—this being evident from the shells being found in a row in pairs, while in other places the dead are found separated from their shells and all cast up together by the waves—is cited as proof that water formerly covered parts of the earth which are now far above the level of the sea, and that this condition continued for a period of more than the forty days of the Deluge, because, as the cockle travels along a furrow at the rate of three or four braccia daily, it could not in forty days have proceeded from the Adriatic to Monferrato in Lombardy, a distance of 250 miles. By an investigation of the cuttings formed by the Arno in the successive strata of which the shells are found, he shows the gradual changes in the crust of the earth, and, following on the track of this knowledge, he essays the construction of the map of Italy in days remote beyond record, but of which the earth remains a living witness.

His special interest in botanical study may be traced back to the earliest period of his artistic work. Vasari tells of a cartoon, intended for tapestry, of the sin of Adam and Eve in Paradise, where was a meadow with innumerable plants and animals, "of which in truth one could say that for diligence and truth to Nature divine wit could not make the like." He mentions a fig-tree as of special excellence for the foreshortening of the leaves and the disposition of the branches, and also a palm in which the roundness of the fan-like leaves was shown with marvellous art. His description suggests minute attention to detail on the part of the artist based upon a profound study of Nature, and these are the characteristics which find expression in Leonardo's many exquisite studies of plants and flowers, and in the treatment of the herbage in the Virgin of the Rocks in the Louvre. His study of botany was in inception an integral part of his treatise on painting, botany being as necessary as anatomy, in order that the painter might have the requisite knowledge of form and structure. But here also the artist's power of observation of the varied beauty of earth's raiment of plants and flowers is merged imperceptibly in the mood of the man of science who saw in Nature not only form and colour, but, above all, light, which St. Augustine called "the queen of colours," and uses Nature's profusion as a background whereon to study the incidence of light and shade.

Leonardo's researches in structure are so exact and so scientific in method as to anticipate the results of subsequent inquiry, as, for instance, in the knowledge his writings reveal of phyllotaxis—the law of quincuncial arrangement of the leaves on the stem—promulgated in 1658 by Sir Thomas Browne in his "Garden of Cyrus." In like manner the discovery that the age of a tree may be told from the number of concentric rings visible in a section of its trunk, with which more than a century later the names of Nathaniel Grew and Marcello Malpighi are associated, is contained in a passage in Leonardo's "Treatise on Painting" (Ludvig, 829). Leonardo also states in the same passage that these rings vary in thickness according to the greater or less amount of humidity of each year.

I have attempted here to summarise a few of the results attained in the course of this investigation. The breadth and variety of their scope may serve to recall the remark of Francis I., who is recorded by Benvenuto Cellini to have said that "he did not believe that any other man had come into the world who had attained so great knowledge as Leonardo."

Aeronautical Research.

THE announcement by the Air Ministry of the future arrangements for aeronautical research and education marks an important stage in the history of the subject. The course followed was indicated in a White Paper, noticed in NATURE of March 4, p. 14, containing the report of a Committee on Education and Research in Aeronautics. The chairman of that Committee, Sir Richard Glazebrook, is now head of the new Aeronautical Research Committee and Zaharoff professor at London University. He was for twelve years chairman of the late Advisory Committee for Aeronautics under the presidency of the late Lord Rayleigh, and it may fairly be claimed that the new advance in the direction of the co-ordination of research in a large subject is a consequence of the success of the work of the earlier body. The Advisory Committee for Aeronautics had the assistance of such eminent men of science as Sir Horace Darwin, Sir Joseph Petavel, Sir Dugald Clerk,

Sir Napier Shaw, Mr. F. W. Lanchester, and Sir George Greenhill. The new Committee differs considerably from the older one in its *personnel*, and indicates an apparent break in continuity. This is not wholly the case, for many of the new members of the Research Committee have for some time been members of sub-committees of the Advisory Committee. It was inevitable that the end of a strenuous period, such as that which brought the war to a close, should be taken as a suitable time for the withdrawal of the older members from some of their activities, and this has happened to a great degree in the case of the members of the Advisory Committee for Aeronautics. The place of such members is taken by specialists in aeronautics together with one or two men of science of wide experience.

It was recommended, in the report referred to, that funds should be provided for a school of aeronautics at the Imperial College of Science, South Kensington, to which institution the Zaharoff chair of aviation was attached. The Treasury has approved of the necessary funds being provided, and steps have now been taken for the formation of the necessary educational staff. The Committee's scheme recommended that this staff should include, in addition to the Zaharoff professor, whole-time professors of aerodynamics and airship construction, together with part-time teachers on design, materials, aero-engines, meteorology, navigation, and airships, and a whole-time junior staff. Mr. L. Bairstow, a former student of the college, has been appointed to the chair of aerodynamics. His work at the National Physical Laboratory on the stability of aircraft is well known and constitutes an important advance in aeronautical engineering. Mr. Bairstow is a member of the new Aeronautical Research Committee, and this dual position—like that of Sir Richard Glazebrook—should afford ample facility to enable the Research Committee to supervise the educational work of the new school.

In general the scheme proposed attempts to provide a common meeting-ground for everybody connected with aeronautics. As a central body responsible for advice and criticism and for the broad lines of policy in research, the Advisory Committee for Aeronautics proved to be of the greatest value. It had no direct executive powers, although the National Physical Laboratory had departments in aeronautics provided solely for carrying out the wishes of the Committee.

The experience gained is apparently considered by the Air Ministry to have justified an extension of powers, and, in particular, the contact with full-scale research at Farnborough and elsewhere is made of the same character as that previously holding for the model work at the National Physical Laboratory. In addition, the Committee has intimate relations with the Imperial College for educational needs. The terms of reference to the Committee and the delimitations of the respective responsibilities of the Air Ministry and the Department of Scientific and Industrial Research give some indication of the very complex arrangements contemplated. Control in all directions is divided, and it is some consolation in these troubled times to find the whole of the essential elements of aeronautics combining to give a fair and generous trial to a scheme without definite rules, *i.e.* to a scheme which assumes helpful co-operation as the basis of success. Whatever difficulties may appear in this direction can only be known later, but it may be hoped that the new Committee will be a worthy successor to the Advisory Committee for Aeronautics and so help to confirm a healthy precedent in the relations of industry and research to the Departments of State.

Conjoint Board of Scientific Societies.

THE report for the year 1919 gives evidence that the Board continues to discharge useful work. During the year there was a danger that supplies of casein and glue would fall short, and that aeroplane manufacture would suffer thereby. The Board came to an arrangement with the Air Group of the Ministry of Munitions, and carried out a research into the nature, functions, and manufacture of adhesives. This resulted in the discovery of two new adhesives, one possessing very remarkable properties, and the other prepared from a waste product of which there was a large supply in the country throughout the war. In addition to this, Dr. Schryver and his colleagues devised improvements in the manufacture of casein which effect a considerable saving in material and an improvement in its quality.

The Committee on the Water-power of the Empire, with Sir Dugald Clerk as chairman and Prof. A. H. Gibson as secretary, drew up a second report, in which it is able to claim that it has stimulated interest in water-power investigations in many parts of the Empire. In India, Ceylon, British Guiana, Australia, the Union of South Africa, and the East Africa Protectorate steps are being taken by the appointment of commissions or committees, or by preliminary investigation and survey, to estimate the water-power supplies which will be available, and in several instances the committee has been asked to give guidance and assistance. Much new development is taking place in New Zealand. A proposal has been put forward to hold an Imperial Water-power Conference in London. Attention is directed to the general lack of facilities in universities and technical institutes for the specialised training of young men in hydro-electric engineering.

The committee of which Sir Robert Hadfield is chairman has sent deputations to interview Sir Alfred Mond and Mr. Stanley Baldwin (on behalf of the Chancellor of the Exchequer) in order to put forward its opinion that there is a great need for better and more centralised accommodation for the technological and scientific societies.

The Patent Laws Committee drew up a series of recommendations, which were adopted by the Board and transmitted to the Federation of British Industries for use in its endeavour to introduce modifications into the new Patent Laws.

An elaborate report on the advisability or otherwise of the compulsory adoption of the metric system, drawn up by a committee with Mr. Wilson-Fox as chairman and Mr. A. R. Hinks as secretary, was discussed at a special meeting of the Board called for the purpose. The report, which envisages boldly the actual practical difficulties which would confront compulsory adoption, especially during the war, is shortly to be published on the authority of the committee, accompanied by a series of criticisms on the part of the scientific and technical societies to which it has been submitted.

Other pieces of work summarised in the report relate to such subjects as the supply of timber for aeroplanes, the establishment of geophysical and petrophysical institutes, and the place of science in warfare.

The Board has also taken its share in the discussion of the formation of national and international research councils, and in advocating the publication of a work devoted to the mineral resources of the Empire. The Bulletin, which is printed and issued to the conjoint societies and the members of the Board, gives in a comprehensive form a forecast of the meetings of the societies and an early announcement of the papers to be read thereat.

Agricultural Development in the West Indies.

THOSE interested in tropical agriculture will find much worthy of attention in a paper on "Tropical Departments of Agriculture, with Special Reference to the West Indies," written by Sir Francis Watts, Imperial Commissioner of Agriculture for the West Indies, and published in the Journal of the Royal Society of Arts (February 20). The paper contains a very interesting account of the evolution of tropical Departments of Agriculture, pointing out that these Departments had their origin in the botanical gardens which were started in the larger islands in the eighteenth century, and also in the mission gardens which the early missionaries cultivated around their stations. The author traces the decline of the British West Indian sugar industry, and the efforts to revive it and to stimulate agriculture by the formation of botanical departments in the smaller islands. Economic conditions, however, became worse, and in 1896 the West Indian Royal Commission was appointed, and its report marks a period in West Indian history. As an outcome of this report the Imperial Department of Agriculture was constituted, the expense of which was met by Imperial funds. The policy of the Department was to revive, extend, and improve the already existing botanic gardens. This action so fostered agricultural development that, at the end of ten years, the Colonial finances had so improved that it was decided to diminish progressively the Imperial grants to the various stations, until in 1912–13 these grants ceased. Sugar production is still a highly important industry; it has been very much improved; the pests and diseases of the sugar-cane are understood, and, what is more important, the growers know how to control the pests; also, the sugar produced by the factories is now a much more valuable product than the old muscovado sugar. The cacao and lime industries have been studied and improved; some minor industries, *e.g.* onion-growing, have also been studied to the advantage of the growers; while encouragement has been given to the production of such crops as maize for home consumption. The latter activity is especially important at the present time, when a wheat shortage is threatened.

A Simple Viscometer.

PARTICULARS of a remarkably simple viscometer devised by Mr. A. G. M. Michell, of Melbourne, are given in *Engineering* for April 16. The instrument is intended for workshop use, and gives rapid determinations of viscosity in absolute measure without requiring extraordinary care or skill. It consists of a cup fitted with a handle and a ball of the same curvature as the cup. Contact of these surfaces is prevented by three symmetrically disposed projections in the cup, raised a mil or two above its surface. The cup is held by its handle, and a few drops of the oil to be tested are placed in it. The ball is then placed in the cup and pressed firmly into it for five or ten seconds. This drives some of the oil out, which collects in a channel; enough oil must be provided in the first instance to ensure that the channel is filled. The instrument is then inverted, and the time taken for the ball to drop clear noted. This time in seconds divided by the constant of the instrument is equal to the absolute viscosity of the oil. The action depends upon the rate at which the oil-film between the cup and the ball thickens under the force of gravity exerted by the ball. This flow of oil is resisted by its viscosity, and the time taken for the ball to fall clear is accordingly directly proportional to the viscosity. The above method is sufficiently accurate for workshop use. To obtain accurate results, the ball is placed at the bottom of a vessel containing a considerable quantity of the liquid. The cup is then lowered over the ball, taking care to exclude air. After pressing the two together as before, they are lifted until the ball clears the bottom of the vessel, and the time it takes to drop clear is noted as before. Mr. W. Ramsay, of Messrs. Cammell and Laird, has made as many as 120 most concordant readings in two hours, and the results plotted quite regularly. With liquids of very low viscosity, the ball is suspended from the arm of a balance. By adjusting the weights, the force tending to separate the ball from the cup can be diminished to, say, one-twentieth of the normal. This increases twentyfold the time needed to effect the separation. The manufacture in this country has been undertaken by Messrs. Michell Bearings, Ltd., 3 Central Buildings, London, S.W.1.

The Chemical Society and its New By-laws.

IT is not surprising in these days, when the old political order has been challenged in so many quarters, that even the scientific societies should be moved to recast their constitution and government in a democratic sense. The Chemical Society is the latest to complete this process of revision, and a record of the chief points in which changes have been made is of public interest.

As a preliminary to any fundamental alterations, a supplemental charter was found to be necessary. The original charter of 1848 included many hampering restrictions, prescribing, for example, the maximum size of the council and the manner of its election. Such provisions, devised for the conduct of a small society associated mainly with London and the immediate districts, are quite unsuitable now that the society numbers more than 3500 fellows, and when probably about two-thirds of these reside beyond the metropolitan area.

There has been some doubt also whether, under the original charter, it was permissible to elect women as fellows of the society. Uncertainty on this point has now been removed by the supplemental charter, which provides that fellows may be of either sex.

Another important feature of the new by-laws based on the supplemental charter is the attempt to secure for provincial fellows a greater share in the conduct of the society. Hitherto every important matter affecting the society, including the election of officers and council, has been determined at a general meeting by a majority of the fellows present and voting. Under the supplemental charter the society has power to elect the officers and council by a postal vote, and further, in certain cases, to take a poll of all fellows resident in the United Kingdom. These powers have been incorporated in the new by-laws.

Another important aspect of these is that there has been kept in view the contingency of combined action with kindred societies concerned in the development of chemical science, as, for example, in the possible acquisition of common premises, or in the publication of joint abstracts. Under the new provisions there will be greater liberty to deal with such a situation if and when it arises, and it may be that these particular modifications of the by-laws will prove to be amongst the most important that have been made.

University and Educational Intelligence.

CAMBRIDGE.—The syndicate appointed to consider the relation of women students to the University has presented a double report. One-half of its members are in favour of admitting women to full membership of the University with a few limitations affecting special posts. They specifically exclude in their proposed statute the recognition by the University of women students at the men's colleges, but they throw open University lectures, examinations, degrees, offices, and emoluments to women on the same terms as to men. The legislation they propose will give degrees to past students of Girton and Newnham.

The report of the second half of the syndicate contains a long discussion of the question. Their actual proposal boils down, however, to a recommendation that the Senate should express itself in favour of a new university being formed from Girton and Newnham Colleges, the intention being to preserve for their students the facilities at present extended to them by the University of Cambridge. The advantages accruing to women students under this proposal would be the awarding of degrees and official consultations between the men's and the women's universities on examination schedules. There is a controversy ahead ending in a contest to which the outside voter will doubtless be summoned by both parties.

Sir Geoffrey Butler, Corpus Christi College, has been appointed secretary of the Board of Research Studies; correspondence in connection with students desiring to come to Cambridge to work for the Ph.D. degree should be addressed to him.

Mr. H. F. Gadow has been appointed reader in the morphology of vertebrates; Dr. H. Scott curator in entomology; Mr. G. F. C. Gordon superintendent of the engineering workshops; and Mr. L. G. P. Thring superintendent of the engineering drawing office.

MR. T. HARRISON HUGHES has made the generous gift of 50,000*l.* to the University of Liverpool as a contribution to the appeal for funds.

A PUBLIC lecture on "The Life-movements of Plants" will be delivered at University College, London, by Sir Jagadis C. Bose on Monday, May 17, at 5.30.

A HOLIDAY course in geology will be held at the School of Metalliferous Mining, Camborne, Cornwall, from July 12 to August 23. The course will consist of lectures, laboratory work, and field work, and occupy five days a week. The lectures will deal with the geology of West Cornwall, with special reference to the economic side.

A LIMITED number of free places, tenable at the Imperial College of Science and Technology, South Kensington, are being offered by the London County Council to candidates who can show that they are qualified to enter on the fourth, or post-graduate, year of the course of study selected. Applications must be made upon Form T2/255 A., obtainable from the Education Officer, L.C.C., Victoria Embankment, W.C., and sent in by, at latest, June 5.

THE council of the London (Royal Free Hospital) School of Medicine for Women will award, in June next, the Dr. Edith Pechey Phipson post-graduate scholarship of the annual value of 100*l.* and tenable for three years. The scholarship is open to all medical women, preferably coming from India or going to work there, for assistance in post-graduate work. Applications are receivable by the warden and secretary of the school, 8 Hunter Street, Brunswick Square, until May 31.

DURING the period immediately following the Armistice it was necessary to adopt temporary measures to fill vacancies in Civil Departments otherwise than by open competitive written examination. The scheme, authorised by Order in Council and under regulations of the Civil Service Commission, has been known as the Reconstruction Scheme. Under that scheme, men who have served in his Majesty's Forces have been chosen to fill positions in the Civil Service by interview before a selection board, following a qualifying examination. The scheme, which has been applied to the Home Civil Service (Class I.), the Indian Civil Service, the Colonial Civil Service, junior or intermediate appointments, and officerships of Customs and Excise, is now coming to an end; and the Civil Service Commissioners announce that the last day for the receipt of applications under it (which must be on the prescribed form) is June 30, 1920, and that *no application received after that date can be considered.* This announcement does not apply to appointments in the Foreign Office and Diplomatic Service or in the Consular Service, which it is intended to make on the Reconstruction Scheme until the end of the year 1921.

THE various associations of teachers in Lancashire and Cheshire engaged in different spheres and branches of education, ranging from the Private Schools Association to the Universities of Liverpool and Manchester, and including all grades and phases of education, have formed themselves into a federal council comprised of two or more representatives from each association or branch with the purpose of considering the further co-ordination of education in Lancashire and Cheshire, and of bringing into closer association teachers who are engaged in different branches of educational work. The council comprises thirty-two representatives, with Principal J. C. M. Garnett as chairman, from fourteen different teachers' associations, and the federal council thus constituted met in Manchester on October 26, 1918. At a later meeting the council appointed special committees to investigate the following matters:—(*a*) The interrelation of the various types of schools and the age of transfer, together with a national scholarship system; (*b*) the curricula of the several types of schools; (*c*) the training and supply of teachers; and (*d*) the means and methods whereby teachers may secure a more effective voice in the administrative control of education. The recommendations of these committees are set forth in a statement of some seventy pages, published at 1*s.* by the Manchester University Press, entitled "A National System of Education: Some Recommendations for Establishing it in England during the Decade Ending Ten Years Hence." The statement includes an introduction, being a lecture delivered by Principal Garnett in January last, which is accompanied by an elaborate coloured diagram setting forth the various grades of education for different classes of children according to their opportunities and capacities and their probable future in life. The pamphlet describes nine types of educational institutions and sixteen different types of education, but whether these could not with much advantage be seriously reduced in number is a matter for the grave consideration of educators. It is suggested that there should be established upon the lines of this federal council a provincial joint committee for each of some eight or ten provinces into which England and Wales should be divided for the purposes of education.

Societies and Academies.

LONDON.

Royal Society, April 29.—Sir J. J. Thomson, president, in the chair.—Prof. J. W. **Gregory**: The Irish eskers. Eskers are banks of sand and gravel, typically occurring as ridges on the central plain of Ireland, where they were deposited during the recession of the ice at the close of the Glacial period. They have been generally attributed to deposition along glacial rivers, like Swedish *osar*. Their structure and composition indicate that the most important Irish eskers were formed along the margin of the receding ice-sheets by floods of water, due to the melting of the ice. Irish eskers formed along glacial rivers are relatively small and exceptional. The accumulation of the materials into ridges, and their restriction between about 150 ft. and 300 ft. above sea-level, are attributed to the formation of the eskers where the ice entered into a sheet of water, which was probably the sea, since marine fossils are widely distributed in the adjacent drifts, and there are no embankments to maintain glacial lakes at the required level. It is proposed that the term "esker" should be continued for Irish ridges and mounds of sand and gravel, but that in glacial geology the term "*osar*" should be used for ridges formed along the course of glacial rivers, and "*kame*" for ridges deposited by water along the margin of an ice-sheet.—Miss K. M. **Curtis**: The life-history and cytology of *Synchytrium endobioticum* (Schilb.), Perc., the cause of wart disease in potato. The life-history and cytology of the organism have been followed through all their stages. In the course of the investigation the following important points have been determined: (1) A sexual process has been discovered and followed in all its details; (2) the nature of the difference between the resting (or winter) sporangia and the sori (or summer sporangia) has been established; (3) the infection of the host-tissue by the zoospores and zygotes has been traced; and (4) the peculiarities in the behaviour of the nucleus of the parasite have been investigated.—B. **Sahni**: The structure and affinities of *Acmopyle pancheri*, Pilger. Acmopyle, a monotypic New Caledonian Podocarp, is the most specialised member of the Podocarpineæ, and closely allied to the genus Podocarpus, which it resembles in the vegetative anatomy, drupaceous seed, megaspore membrane, young embryo, structure of male cone, microsporophyll, pollen-grain, and probably male gametophyte. It differs from Podocarpus in (1) the nearly erect seed; (2) the complete fusion of the epimatium to the integument, even in the region of the micropyle, in the formation of which it takes part; and (3) the much greater development of the vascular system of the seed, which forms a nearly continuous cup-like tracheal investment covering the basal two-thirds of the stone. (*a*) The Taxineæ are structurally so distinct from the remaining conifers as to justify their being placed in a separate phylum, Taxales, equivalent in rank, and related to, the Ginkgoales and the Coniferales as here defined. The Cordaitalean affinities of the Taxales are emphasised. (*b*) Concerning the ovuliferous scale of the conifers, the conclusion is in favour of the brachyblast theory, support for this view being derived from the structure of the megastrobilus of Acmopyle. (*c*) No definite opinion is expressed on the question whether the conifers arose ultimately from microphyllous or megaphyllous ancestors, for the origin of the Cordaitales themselves is still regarded as *sub judice*.

Zoological Society, April 27.—Dr. A. Smith Woodward, vice-president, in the chair.—F. F. **Laidlaw**: Contributions to a study of the dragon-fly fauna of Borneo. Part iv.: A list of the species known to occur in the island.—Dr. R. **Broom**: Some new Therocephalian reptiles from the Karroo beds of South Africa.

MANCHESTER.

Literary and Philosophical Society, March 16.—Mr. William Thomson, vice-president, in the chair.—Prof. R. **Robinson**: Note on the mechanism of the production of kynurenic acid in the dog. The formation of kynurenic acid from tryptophane is susceptible of a very simple representation involving normal reactions. The process appears to be primarily one of oxidation followed by decomposition of a carbamic acid derivative, and a probably spontaneous closing of the quinoline ring.—Prof. A. **Lapworth**: Latent polarities of atoms and mechanism of reaction, with special reference to carbonyl compounds. A consideration of the properties of carbonyl compounds shows that divalent oxygen and tervalent nitrogen tend to cause a latent polarisation in the molecules of carbon compounds. When this occurs in a molecule, the other atoms in the neighbourhood show induced latent polarities which the writer indicates by attaching − and + signs to the atoms in alternating order, beginning with the "key atoms," arriving at schemes like those adopted by Fry and others. The induced polarity of an atom or group is not interpreted as necessarily signifying an electric charge, but only as an enhanced or diminished tendency to attract or repel other atoms (or electrons) with definite polar character, and that only at the moment of chemical change (or ionisation, when this occurs). A condition which appears necessary for the full extension of the inductive effect is the occurrence of double bonds (conjugation?), though it may survive the intervention of two successive single ones. While divalent oxygen and tervalent nitrogen (and especially the former) seem more effective than any other atoms, it would appear that halogen (−), hydrogen (+), and metals (+) can act as "key atoms" to a smaller extent; carbon appears almost indifferent. This principle includes Markownikoff's rule of addition, the rules of substitution in the benzene series, the rules of reaction of saturated and unsaturated ketones, nitriles, and carboxylic acids, as well as of their halogen derivatives. The influence of hydrogen as a "key atom" is perceptible in the cresols, of which the relative acidities can be foreseen from a consideration of the influence of the hydrogen atom in the methyl groups on the latent polarities of the atoms in hydroxyl groups.—Prof. R. **Robinson**: The conjugation of partial valencies. The author deals with the mechanism of chemical processes on the basis of a hypothesis of divisible valency, assuming that activation of molecules is due to a partial dissociation or splitting of valencies, and that only molecules so polarised take part in reactions. This accounts for the well-recognised effect of polar atoms on alternate atoms in a chain, and the theory is extended to include cases such as the addition of hydrogen bromide to allyl bromide, where the conjugation of ethylene linkage and bromine atom is relatively weak. Conjugated decompositions and the problem of molecular rearrangement are dealt with.

PARIS.

Academy of Sciences, April 19.—M. Henri Deslandres in the chair.—G. A. **Boulenger**: The fossil Gavialis of Omo.—A. **Vayssière**: The marine fauna of the western coast of the Gulf of Marseilles.—G. **Julia**: New properties of certain very general classes of integral or meromorphic functions.—W. **Sierpinski**: Functions of the first class.—Fr. **Lange-Nielsen**: A generalisation of Rolle's theorem.—J. **Villey**: Flight at high alti-

tudes. Reply to some criticisms of M. Rateau on an earlier communication.—E. **Brylinski**: The transport of electrical energy to great distances. A mathematical discussion of the properties of a half-wave line.—S. **Posternak**: The variations of the composition of ammonium phosphomolybdate. An account of the variations in the composition of the precipitate produced by the presence of ammonium nitrate or sulphate in the liquid in which the precipitate is formed.—F. **Bourion**: The analysis of commercial chlorobenzenes by distillation. The substances present in the commercial product are benzene, monochlorobenzene, and higher chlorination products boiling at 80° C., 130° C., and 172° C. or above. A scheme for systematic fractional distillation is given, with results for synthetic mixtures. The method is a lengthy one, a single sample requiring three and a half days for analysis.—G. **Mignonac**: The ketimines. Formation by the catalytic reduction of the oximes. The reaction was carried out with nickel (reduced from its oxide at 300° C.) in absolute alcohol at ordinary atmospheric pressure at a temperature of about 16° C. The oxime of *cyclo*hexanone gave N-*cyclo*hexylketimine, a substance not previously isolated, and the corresponding ketimines were isolated from the reduction products of the oximes of acetophenone, propiophenone, benzophenone, and phenyl-α-naphthyl ketone.—Mlle. S. **Veil**: Alloys of oxides. Mixtures of the oxides of chromium and cerium were compressed and heated, and measurements made of the electrical conductivity and magnetisation coefficient of the products. Diagrams are given showing the results for varying proportions of the two oxides.—C. **Matignon** and J. A. **Lecanu**: The reversible oxidation of arsenious acid. From the thermochemical data it should be possible directly to oxidise arsenic trioxide to the pentoxide, and experiments were carried out at temperatures between 400° C. and 450° C., the pressures of the oxygen being 130, 127, and 138 atmospheres. The production of the pentoxide was proved, but the oxidation of the arsenic trioxide was not complete.—Ch. **Gorceix**: The formation of the first ocean.—R. **Souèges**: The embryogeny of the Œnotheraceæ. Development of the embryo in *Oenothera biennis*.—M. **Moilliard**: The influence of a small quantity of potassium on the physiological characters of *Sterigmatocystis nigra*. Potassium has a marked specific action on the development of this mould. Deficiency of potassium causes the glucose in the culture fluid to disappear more rapidly than the lævulose; conidia and black pigment do not appear as usual; a golden-yellow pigment appears in the fluid, and a soluble substance stained blue by iodine is formed.—G. **Bertrand**: The conditions which may modify the activity of chloropicrin towards the higher plants. The effects of chloropicrin are nearly proportional to the concentration of the vapour and the time of action. Moisture and light, except direct sunlight, are without influence.—M. **Baudouin**: An anatomical measurement permitting the diagnosis of sex in the human skull.—L. **Boutan**: Comparative yields of pelagic apparatus.—P. **Wintrebert**: The propagation of the undulating movement of the muscles of the skeleton in advanced embryos of *Scylliorhinus canicula* after section or partial resection of the spinal cord.—P. **Portier**: The rabbit deprived of its cæcal appendix regenerates this organ by differentiation of the extremity of the cæcum. When the rabbit's appendix is removed the terminal portion of the cæcum is modified, becomes infiltrated with lymphocytes, and regenerates a new appendix possessing the essential histological and physiological characters of the normal appendix. This is a proof of the important function of this organ in the rabbit.—Ch. **Porcher**: Lacteal retention.—M. **Doyon**: The anti-coagulating and hæmolysing action of sodium nucleinate.—P. **Courmont** and A. **Rochain**: The action of the micro-organisms of sewage effluents purified by the activated-sludge method on albuminoid materials, urea, and nitrates.—E. **Aubel**: The sterilising power of acids.

Books Received.

School Dynamics. By W. G. Borchardt. Part i. (with Answers.) Pp. vii+286+xix. (London: Rivingtons.) 3*s*. 6*d*.

Space and Time in Contemporary Physics. By Prof. M. Schlick. Rendered into English by H. L. Brose. Pp. xi+89. (Oxford: At the Clarendon Press.) 6*s*. 6*d*. net.

Zoölogy: A Text-book for Colleges and Universities. By Prof. T. D. A. Cockerell. Pp. xi+558. (Yonkers-on-Hudson, New York: World Book Co.) 3 dollars.

An Introduction to Palæontology. By Dr. A. M. Davies. Pp. xi+414. (London: T. Murby and Co.) 12*s*. 6*d*. net.

Practical Plant Biochemistry. By M. W. Onslow. Pp. vii+178. (Cambridge: At the University Press.) 15*s*. net.

Wild Fruits and How to Know Them. By Dr. S. C. Johnson. Pp. xi+132. (London: Holden and Hardingham, Ltd.) 1*s*. net.

Aluminium: Its Manufacture, Manipulation, and Marketing. By G. Mortimer. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Cotton Spinning. By W. Scott Taggart. Vol. iii. Fifth edition. Pp. xxviii+490. (London: Macmillan and Co., Ltd.) 10*s*. net.

Diary of Societies.

THURSDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. P. Graves: Welsh and Irish Folk Song.

ROYAL SOCIETY, at 4.—Election of Fellows.—4.30.—Dr. A. D. Waller: Demonstration of the Apparent "Growth" of Plants (and of Inanimate Materials) and of their Apparent "Contractility."—W. N. F. Woodland: The "Renal Portal" System (Renal Venous Meshwerk) and Kidney Excretion in Vertebrata.

LONDON MATHEMATICAL SOCIETY, at 5.—H. W. Richmond: (1) Historical Note on some Canonical Forms quoted by Mr. Wakeford. (2) Historical Note on Cayley's Theorems on the Intersections of Algebraic Curves.—T. Stuart: The Lowest Parametric Solutions of a Dimorph Sextan Equation in the Rational, Irrational, and Complex Fields.—A. E. Jolliffe: The Pascal Lines of a Hexagon.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers) at 6.—S. Evershed: Permanent Magnets in Theory and Practice.

INSTITUTE OF INVENTORS (at Royal Society of Arts), at 7.30.—D. Leechman and Others: Discussion on The Relations of the Inventor to the State.

OPTICAL SOCIETY, at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Section) (at 28 Victoria Street), at 8.—W. E. Benbow: The Chemical and Physical Properties of Iron and Steel.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Annual General Meeting.—Dr. S. A. K. Wilson: Decerebrate Rigidity in Man, and the Occurrence of Tonic Fits.

FRIDAY, MAY 14.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Conference of Research Organisations (at Institution of Civil Engineers), at 3.—Marquess of Crewe: Introductory Address.—Dr. A. W. Crossley: The Relation of Research Associations to Existing Institutions for Research.—J. W. Williamson: The Staffing of Research Associations: Salaries and Superannuation.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON, at 5.—Dr. F. Lloyd Hopwood: Demonstration of Experiments on the Thermionic Properties of Hot Filaments.—G. D. West: A Modified Theory of the Crookes Radiometer.—A. Campbell: The Magnetic Properties of Silicon-Iron (Stalloy) in Alternating Fields of Low Value.—T. Smith: Tracing Rays through an Optical System.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.
MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at King's College), at 7.—E. G. Humfress: Electrical Motor Control Devices.—The Meeting will be preceded by the Annual General Meeting.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Hon. H. Fletcher Moulton and Others: Discussion on The Business Aspect of the Peace Treaty.
SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.30.—Dr. E. J. Wood: A Consideration of Pellagra from the Standpoint of a "Deficiency Disease."
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Karl Pearson: Sidelights on the Evolution of Man.

SATURDAY, MAY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Frederic Harrison: A Philosophical Synthesis as proposed by Auguste Comte.

MONDAY, MAY 17.

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Bishop G. Forrest Browne: Monumental Art in Early England, Caledonia, and Ireland.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—B. J. Lubschez: The Two Great Railway Stations of New York.
ROYAL SOCIETY OF ARTS, at 8.—A. T. Bolton: The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837 (Cantor Lectures).
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. F. Kingdon Ward: The Valleys of Kham.

TUESDAY, MAY 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: British Ethnology: The Invaders of England.
ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.
ROYAL STATISTICAL SOCIETY, at 5.15.—Y. B. Guild: Variations in the Numbers of Livestock and in the Production of Meat in the United Kingdom during the War.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—R. Stirling: Air Lift System of Pumping Oil Wells.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—A. C. Vowles: Wanderings in Mesopotamia (Babylon).
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Sir Henry Howorth: Buddhism in the Pacific.

WEDNESDAY, MAY 19.

SOCIETY OF GLASS TECHNOLOGY (at Institute of Chemistry), at 2.—C. J. Peddle and Others: Discussion on The Physical Properties of Glass.—C. J. Peddle: The Development of Various Types of Glass. Part i.: The Interaction of Silica with the Oxides of Sodium and Potassium. Part ii.: The Interaction of Silica, Lime, and Sodium Oxide. Part iii.: The Interaction of Silica, Lime, and Potassium Oxide. Part iv.: The Interaction of Silica, Lime, and the Oxides of Sodium and Potassium. Part v.: A Comparison of the Soda-Lime-Silica and the Potash-Lime-Silica Glasses.—Dr. M. W. Travers: A Surface Effect in Glass, Probably Caused by Re-heating.—S. English and Dr. W. E. S. Turner: The Thermal Expansion of Magnesia-containing Glasses.—J. R. Clarke and Dr. W. E. S. Turner: The Optical Properties of Some Lime-Soda Glasses.—S. English and Dr. W. E. S. Turner: The Annealing Temperatures of Soda-Lime and Soda-Magnesia Glasses.—J. D. Cauwood, J. R. Clarke, Miss C. M. M. Muirhead, and Dr. W. E. S. Turner: The Durability of Lime-Soda Glasses.—J. R. Clarke and Dr. W. E. S. Turner: The Influence of Lime on the Value of Young's Modulus of Elasticity for the Lime-Soda Glasses.—S. English and Dr. W. E. S. Turner: The Density of Soda-Magnesia Glasses and a Comparison with that of the Soda-Lime Glasses.
ROYAL SOCIETY OF ARTS, at 4.30.—J. S. Highfield, Dr. W. R. Ormandy, and D. Northall-Laurie: The Commercial Applications of Electrical Osmosis.
ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Annual General Meeting.—Dr. Withington: The Medical Terms in Liddell and Scott.
ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. Griffith Taylor: Agricultural Climatology of Australia.—J. E. Clark and H. B. Adames: Report on the Phenological Observations for 1919.
GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. H. H. Thomas: Certain Xenolithic Tertiary Minor Intrusions in the Island of Mull (Argyllshire).
ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Exhibition of Microscopic Pond Life.

THURSDAY, MAY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. P. Graves: Welsh and Irish Folk Song.
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. J. N. Collie: Some Notes on Krypton and Xenon.—Sih Ling Ting: Experiments on Electron Emission from Hot Bodies, with a Preface by Prof. O. W. Richardson.—Dr. L. Silberstein: The Aspherical Nucleus Theory Applied to the Balmer Series of Hydrogen.—Dr. T. E. Stanton, Miss D. Marshall, and Mrs. C. N. Bryant: The Conditions at the Boundary of a Fluid in Turbulent Motion.
ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Brig.-Gen. Lord Montagu of Beaulieu: Roads and Transport in India.
ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—G. Rigg: Roasting and Lead-Smelting Practice at the Port Pirie (S.A.) Plant of the Broken Hill Associated Smelters Proprietary, Ltd.—Capt. H. Tatham: Tunnelling in the Sand Dunes of the Belgian Coast.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 5.30 (Annual General Meeting).
OPTICAL SOCIETY, at 7.30.—B. K. Johnson: The No. 7 Dial Sight, Mk. II.—Lt.-Col. Gifford: A Short High Power Telescope.
CHEMICAL SOCIETY (Ordinary and Informal Meeting), at 8.

FRIDAY, MAY 21.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Annual General Meeting.
WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—P. Coursey: Some Methods of Eliminating Atmospherics in Wireless Reception.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Annual General Meeting.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. A. Fleming: The Thermionic Valve in Wireless Telegraphy and Telephony.

SATURDAY, MAY 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Frederic Harrison: The Re-action and the Critics of the Positivist School of Thought.

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